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(54) **Poxviral vectors and their use as a vaccine against feline infectious peritonitis virus disease.**

(57) The invention that relates to recombinant raccoon poxvirus useful as a Vaccine Against Feline Infectious Peritonitis Virus Disease. The recombinant raccoon poxvirus has at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of Feline Infectious Peritonitis Virus (FIPV).

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Field of the Invention

The present invention pertains to the prophylaxis of disease caused by feline infectious peritonitis virus (FIPV), using recombinant raccoon pox viruses (RRPVs) expressing the nucleocapsid and transmembrane proteins of FIPV as vaccines.

Background of the Invention

Feline infectious peritonitis virus (FIPV) induces a systemic infection in cats that is often fatal. The effusive form of the disease is characterized by accumulation of fibrinous ascitic fluid. The non-effusive form of the disease is characterized by granulomatous lesions in multiple organs including, but not limited to, liver, spleen, kidneys, lung, and intestines. Reviewed in Barlough, J.E. and C. A. Stoddart. Feline Coronaviral Infections in C.E. Greene (Ed.). Infectious Diseases of the Dog and Cats. W.B. Saunders Co., Philadelphia, PA, 1990, pp. 300-312.

Feline infectious peritonitis virus is a coronavirus composed of three major structural proteins: The S (spike) protein, the E1 or M (transmembrane) protein, and the N (nucleocapsid) protein. Venema et al., Virology 181: 327-335, 1991 and Dale, et al., EPO 0,376, 744.

Prior vaccines intended to prevent FIPV infection have actually been shown to exacerbate the disease caused by this virus. Pedersen, N.C. and J.W. Black, Am. J. Vet. Res. 44: 229-234, 1983; Vennema H., et al., J. Virol. 64: 1407-1409, 1990; Barlough, J.E., Can. J. Comp. Med. 49: 303-307, 1985; Barlough J.E. et al., Lab. Anim. Sci. 34: 592-597, 1984; Stoddart, C.A., et al., Res. Vet. Sci. 45: 383-388, 1988; and Pedersen, N.C., Adv. Vet. Sci. Comp. Med. 33: 413-428, 1989. This phenomenon apparently reflects an immune enhancement of infection mediated by immunoglobulins produced in response to the virus, in particular by those antibodies directed against the S protein. Olsen C. W. et al., J. Virol. 4: 175-189, 1981. Therefore, the best candidate vaccine for prophylaxis of this disease would be a preparation that induces strong cell-mediated immunity in the absence of enhancing antibodies. This could be accomplished with a vaccine that lacks the outer envelope protein but contains the other structural proteins of FIPV (N and E1). Prior attempts to vaccinate cats with a recombinant vaccinia virus expressing the N or E1 proteins of FIPV, however, have failed to induce strong protective immunity. Venema et al., Virology 181:327-335, 1991 and Dale, et al., European Patent Application 0,376,744. See also, Venema, European Patent Application 0,411,684.

What is needed in the art, therefore, is an effective vaccine against FIPV that utilizes the N and E1 proteins, or segments therefrom, as immunogens.

Summary of the Invention

The present invention pertains to the induction of protective immunity to FIPV in cats. One object of the invention is to provide recombinant raccoon poxviruses containing the genes for the FIPV N or M/E1 proteins (RRPV-N and RRPV-E1, respectively).

A further object of the invention is to provide a feline vaccine comprising RRPV-N or RRPV-E1, either singly or in combination, or in combination with other viruses, bacteria, or fungi that have been inactivated or attenuated. A still further object of the invention is to provide a method for preventing disease caused by FIPV, by administering to a feline in need of such treatment a vaccine comprising RRPV-N, RRPV-E1, or combinations thereof.

These and other objects and advantages, which will be apparent from this specification, are achieved by the invention described below.

Description of the Drawings

Figure 1 illustrates the nucleotide and amino acid sequence of the FIPV E1 protein and the FIPV N protein (Figures 1A and 1B, respectively.)

Figure 2 illustrates the plasmid used to clone the genes encoding the FIPV E1 and N proteins.

Figure 3 schematically shows the pSC11 transfer plasmids used to create RRPVs encoding the FIPV E1 and N proteins (Figs 3B and 3C, respectively.)

Figure 4 illustrates the nucleotide sequence of pSC11 FIPV E1 and pSC11 FIPV N (Figures 4A and 4B, respectively.)

Figure 5 is a photograph of an ethidium bromide-stained agarose gel showing the analysis of RRPV-FIPV N and RRPV-FIPV E1 by polymerase chain reaction.

Figure 6 is an immunoblot illustrating the detection of FIPV N and E1 proteins in virally infected cell lysates.

Detailed Description of the Invention

The vaccine of the present invention may be prepared by creating recombinant raccoon poxviruses (RRPVs) containing the genes encoding the N or E1 proteins of FIPV or immunogenic fragments thereof. These genes are first inserted into a transfer plasmid, which is then introduced into appropriate host cells that have been previously infected with a raccoon poxvirus. As a result, the DNA from the transfer plasmid is incorporated into the poxvirus DNA by homologous recombination, producing the RRPVs that are released from the cells.

DNA encoding the FIPV N or E1 proteins is inserted into the transfer plasmid immediately downstream of a poxvirus promoter. In a preferred embodiment, the early/late 7.5 Kd protein promoter of vaccinia virus is used; however, alternate promoter elements that are functional in poxviruses can also be used.

The preferred transfer plasmid also contains a beta-galactosidase marker gene, which allows for selection and detection of the plasmid DNA sequences in recombinant viruses. It will be obvious to one skilled in the art that alternative selectable marker genes, such as the neomycin resistance gene or the E. coli gpt gene or others, can be used to practice the invention. Flanking the foreign gene of interest and the selectable marker gene are thymidine kinase DNA sequences, which facilitate recombinatorial integration of the plasmid DNA sequences into the raccoon poxvirus DNA.

Recombinant viruses expressing the FIPV N or E1 genes are prepared by first infecting a susceptible cell line such as Vero (ATCC CCL 81), BSC-1 (ATCC CCL 26), RAT-2 (ATCC CRL 1764), or CRFK (ATCC CCL 941) with wild type raccoon poxvirus (ATCC VR-838 or similar isolates, such as, for example, RCNV71-I-85A). Transfer plasmid DNA containing the E1 or N gene is then transfected into the infected cells using cationic liposome-mediated transfection, or other suitable techniques such as electroporation or calcium phosphate precipitation. Virus replication is allowed to proceed until cytopathic effects are noted in all cells.

Incorporation of the FIPV E1 or N genes into poxvirus DNA is accompanied by disruption of the viral thymidine kinase gene. Therefore, virus harvested from this infection may be isolated by selecting for the absence of a thymidine kinase gene; this is achieved by growth on tk- RAT-2 cells (ATCC CRL 1764) in the presence of 5-bromodeoxyuridine. Viruses containing a gene insert from the transfer plasmid are further identified by the appearance of a blue plaque color when grown in the presence of a chromogenic substrate for beta-galactosidase such as X-gal.

Viral plaques that survive these selection and screening procedures are then subjected to several cycles of plaque purification. Subsequently, the presence of the E1 or N genes is confirmed by polymerase chain reaction technology, and the presence of E1 or N protein is confirmed by immunoblot analysis using specific antibodies. These viruses are designated RRPV-FIPV E1 and RRPV-FIPV N, respectively.

In a further embodiment of the present invention, the genes encoding N and E1 were inserted into a single transfer plasmid. Introduction of this plasmid into cells previously infected with wild-type raccoon poxvirus results in the production of recombinant viruses that express both proteins simultaneously (RRPV-FIPV E1/N).

In a still further embodiment, RRPVs can be produced that express less-than-full-length segments of the FIPV E and N proteins. The techniques used to engineer transfer plasmids encoding partial sequences of E1 and N are well-known and widely used in the art, as are the methods for production and screening of RRPVs as detailed in this specification. For example, introduction of oligonucleotides containing a stop codon at various points along E1 or N DNA will produce a nested set of carboxyterminal-truncated versions of that gene, which can then be incorporated into RRPVs. It will be apparent to one of ordinary skill in the art that systematic screening of such recombinant RRPVs can establish whether the intact protein, or subfragments thereof, are most preferred in practicing the present invention. Furthermore, as stated above, DNA encoding different fragments of E1 and N can be used in a combination vaccine after incorporation into the same, or different, RRPVs.

For vaccine preparation, susceptible cells such as those listed above are infected with RRPVs at a multiplicity of infection (MOI) of 0.1 infectious units/cell or less. In this specification, an infectious unit is defined as a Tissue Culture Infectious Dose (TCID₅₀), an amount of virus yielding 50% infection under defined conditions. A method for TCID₅₀ determination is detailed in Example 1 below. When cytopathology is noted in > 90% of the cells, the infected cells and extracellular fluids (both of which contain viruses) are harvested as a single virus-cell lysate.

The highly concentrated virus stock to be used as a vaccine may be stored frozen (-50°C or colder) or lyophilized until the time of use. Compounds such as NZ-amine, dextrose, gelatin or others designed to stabilize the virus during freezing and lyophilization may be added. The virus initially present in the virus-cell lysate may be further concentrated using commercially available equipment.

Typically, the concentration of virus in the vaccine formulation will be a minimum of 10^{6.5} TCID₅₀ per dose, but will typically be in the range of 10^{7.0} to 10^{9.0} TCID₅₀ per dose. At the time of vaccination, the virus is thawed (if frozen) or, if lyophilized, is reconstituted with a physiologically-acceptable carrier such as deionized water, saline, phosphate buffered saline, or the like.

The present invention is not limited to native (i.e. replication-competent) RRPVs. The virus-cell lysate can be subjected to treatments commonly used in the art to inactivate viruses. A composition comprising inactivated virus and expressed protein will be effective in eliciting protective immunity against FIPV if it contains a sufficient quantity of FIPV protein. This type of vaccine would provide added assurance that recipient felines will not be exposed to infectious FIPV as a consequence of vaccination. In addition, a physiologically-acceptable adjuvant may be added to the virus, such as EMA 31 (Monsanto Co., St. Louis, MO), NEOCRYL (Polyvinyl Chemical Industries, Wilmington, MA), MVP (Modern Veterinary Products, Omaha, NE), Squalene, Pluronic L121, or the like.

Individual raccoon poxviruses expressing the N or E1 genes may be mixed together for vaccination. Furthermore, the virus may be mixed with additional inactivated or attenuated viruses, bacteria, or fungi such as feline leukemia virus, feline panleukopenia virus, feline rhinotracheitis virus, feline calicivirus, feline immunodeficiency virus, feline herpesvirus, feline enteric coronavirus, feline *Chlamydia psittaci*, *Microsporium canis*, or others. In addition, antigens from the above-cited organisms may be incorporated into combination vaccines. These antigens may be purified from natural sources or from recombinant expression systems, or may comprise individual subunits of the antigen or synthetic peptides derived therefrom.

In a further embodiment of the present invention, live or inactivated RRPV virus-cell lysates can be incorporated into liposomes, or encapsulated in peptide-, protein-, or polysaccharide-based microcapsules prior to administration, using means that are known in the art.

The final vaccine is administered to cats in a volume that may range from about 0.5 to about 5 ml. The vaccine can be administered by subcutaneous, intramuscular, oral intradermal, or intranasal routes. The number of injections and their temporal spacing may be varied. One to three vaccinations administered at intervals of one to three weeks are usually effective.

The following examples are intended to further illustrate the invention without limiting its scope. The techniques used to infect and transfect cells, plaque purify virus, perform immunoblot analysis are widely practiced in the art.

Example 1

GENERATION OF RECOMBINANT RACCOON POX VIRUSES EXPRESSING FIPV N AND E1 GENES

1. Cloning of FIPV N and E1 Genes and Preparation of Transfer Plasmids

The sequences of the E1 and N genes used in the present invention are shown in Figures 1A and 1B, respectively, of the specification. The methods for cloning of the N and E1 genes of FIPV and their insertion into a pSC11 transfer vector are detailed in European Patent Application 0,376,744, which is incorporated by reference. The plasmid used to clone the cDNA for the E1 and N genes is shown in Figure 2. The pSC11 plasmids carrying the E1 and N genes are shown in Figures 3B and 3C, respectively. The sequences of these plasmids are shown in Figures 4A and 4B.

To construct a pSC11 transfer plasmid containing both N and E1 genes, a 1.0 kb DNA fragment containing the vaccinia 7.5 promoter and the E1 gene was inserted downstream of the N gene in pSC11-FIPV N. The resulting plasmid was designated pSC11-FIPV N/E1.

2. Preparation of Recombinant Raccoon Poxviruses(RRPVs)

Monolayers of Vero cells (ATCC CCL 81) that were 80% confluent (approximately 5×10^6 cells/100 mm tissue culture dish) were infected for 30-60 minutes at 37°C with wild-type raccoon pox virus (ATCC VR-838) at a multiplicity of infection (MOI) of 0.1 TCID₅₀/cell. The medium (2 ml) consisted of Eagle's Minimum Essential Medium ("MEM", Gibco BRL #4101500) containing 0.05% lactalbumin hydrolysate and 15 µg/ml gentamicin sulfate and adjusted to pH 7.2 with sodium bicarbonate. After infection, the medium was removed and the cells were transfected with the pSC11-FIPV N, pSC11-FIPV E1, or pSC11 N/E1 transfer plasmid by cationic liposome-mediated transfection using Transfectam® (Promega Corporation, Madison, WI) and DOTAP (Boehringer Mannheim, Indianapolis, IN), respectively, per manufacturer's instructions. The cells were incubated with the DNA-liposomes mixture in 3 ml of MEM containing 5% fetal bovine serum (FBS) overnight at 37°C (5% CO₂), after which the medium was replaced with 8 ml of fresh MEM-5 % FBS. The transfected cells were incubated at 37°C (5% CO₂) until greater than 80% showed cytopathic effects (CPE), which took approximately 3-4 days. The virus-cell lysates were then removed from the plates and subjected to two cycles of freeze-thawing before storage at -70°C.

3. Isolation of Recombinant Raccoon Pox Virus Carrying the FIPV N Gene

RRPVs carrying FIPV N gene (RRPV-FIPV N) were isolated and purified from the pSC11-FIPV N- Vero cell transfection by standard viral plaque purification methods. Monolayers of Vero cells (50-80 % confluent) were infected with 2 ml of ten-fold serial dilutions (10^{-1} to 10^{-3}) of the viral-cell lysates for 1 hour at 37°C. After incubation, the media was removed and the infected cells were overlaid with 8-10 ml of 1.25% Noble agar containing MEM/5% FBS. The infected cells were then incubated for 3-4 days at 37°C (5% CO₂), and overlaid again with 4 ml of 1.25% Noble agar containing 0.5X PBS and 600 µg/ml 5-bromo-4-chloro-3-indolyl-β-D-galactopyranoside (X-gal, States Biochemical Cleveland, Ohio). The plates were incubated at 37°C (5% CO₂) for 4-16 hours, until blue (i.e. β-galactosidase positive) viral plaques were observed. The recombinant viral plaques were picked with sterile blunt needles attached to a 1 cc syringe, suspended in 0.5 ml of 0.25 µg/ml trypsin, vortexed vigorously, and incubated at 37°C for 15-30 min. The disrupted viral plaques were then inoculated onto 5 x 10⁵ Vero cells in 25 cm² flasks and incubated at 37°C (5% CO₂) until greater than 80% CPE was observed. The viral-cell lysates containing RRPV-FIPV N were subjected to two cycles of freeze-thawing and stored at -70°C. Six individual RRPV-FIPV N clones were selected and plaque-purified five times as described above.

4. Isolation of Recombinant Raccoon Pox Virus Containing the FIPV E1 Gene

RRPVs carrying the FIPV E1 gene (RRPV-FIPV E1) were isolated and purified from pSC11-FIPV E1-transfected Vero cells using the methods described for RRPV-FIPV N, with some modifications. In this case, thymidine kinase deficient (tk-) RRPVs from the initial virus-cell lysates were selected on tk- RAT-2 cells (ATCC CRL 1764). This was performed by inoculating 1 ml of the initial virus-cell lysate onto a monolayer of RAT-2 cells in a 75 cm² flask (approximately 5 x 10⁸ cells) in the presence of 5-bromodeoxyuridine (BrdU) at 30 µg/ml in MEM. The infected monolayer was incubated at 37°C (5% CO₂) for 3-4 days until greater than 70% CPE was observed. The tk- virus-cell lysates were subjected to two cycles of freeze-thawing before storage at -70°C. Two individual RRPV-FIPV E1 clones were selected and subjected to six cycles of plaque purification as described above for RRPV-FIPV N.

5. Confirmation of FIPV N and E1 Genes in RRPV by Polymerase Chain Reaction

The presence of the FIPV N and E1 genes in the RRPVs was confirmed using the polymerase chain reaction (PCR). 90 µl of a virus-cell lysate were incubated with 10 µl of tenfold concentrated PCR lysis buffer (100 mM Tris-HCL buffer, pH 8.5; 500 mM KCl; 25 mM MgCl₂; 5% Tween 20; 3 mg/ml Proteinase K) for 16 hours at 50°C, then boiled for 10 min. 10 µl of this lysate was used in the PCR. PCR was performed in 100 µl of 10 mM Tris-HCL buffer, pH 8.3; 50mM KCl; 200 µM of each deoxyribonucleotide triphosphate, 1.5 mM MgCl₂; 30 pmoles of each oligonucleotide primer; and 2.5 units of AmpliTaq® DNA polymerase (Perkin-Elmer Cetus, Norwalk, CT). The primers used in the PCR for FIPV N were:

(1) 5'-CTCGTGGTCGGAAGAATAATGATA-3'

(2) 5'-AGCACCATAGAAAGTTGTCACATC-3',

corresponding to nucleotides 68-91 and 721-744 of the FIPV N open reading frame (primers 1 and 2, respectively). The primers used in the PCR for FIPV E1 were:

(3) 5'-TATGTAATGTTTCGGCTTTAGTG-3'

(4) 5'-GTGCTTCTGTTGAGTAATCACC-3'

corresponding to nucleotides 334-355 and 721-742 of the FIPV E1 open reading frame (primers 3 and 4, respectively). The PCR amplifications were performed in a DNA Thermal Cycler (Perkin-Elmer Cetus) by first heating the reaction mixes to 94°C for denaturation, and then performing 35 cycles of amplification, each consisting of 1 min at 95°C, 1 min at 55°C, 2 min at 72°C, and, on the last cycle, a final incubation of 8 min at 72°C. 10 µl of the PCR products were resolved by electrophoresis in a horizontal-submarine 4% NuSieve agarose gel (FMC BioProducts, Rockland, ME) in TAE buffer (40 mM Tris base, 20 mM sodium acetate, 1 mM EDTA, pH 7.2) by applying 5 V/cm for 1-2 hours. The DNA products were visualized by staining the gels with ethidium bromide.

PCR amplifications with the FIPV N and E1 primers gave DNA fragments of 676 and 408 nucleotides, respectively (Figure 5). PCR amplifications using the pSC11 FIPV N and E1 transfer plasmids served as positive controls, and showed products of the predicted sizes. PCR amplifications using wild-type raccoon pox virus-Vero cell lysates served as a negative control, and no PCR products were observed in those samples.

6. Confirmation of RRPV FIPV N and E1 Protein Expression by Immunoblot Analysis

Confluent monolayers of Vero cells in a 25 cm² flask (1-2 x 10⁶ cells) were infected with clones of either RRPV-FIPV N or RRPV-FIPV E1 at an MOI of 0.1. The infected cells were incubated at 37°C (5% CO₂) for 2-3 days until approximately 80% of the cells showed cytopathic effects. A virus-cell lysate was prepared, and 20 µl of the sample were added to 5 µl of 5X Laemmli sample buffer (0.3 M Tris-HCl buffer, pH 6.8, containing 5% SDS, 50% glycerol, 0.4% bromophenol blue, and 3% 2-β-mercaptoethanol) and heated at 95°C for 5 min. The denatured protein samples were separated by SDS/polyacrylamide electrophoresis using a 4-15% gradient polyacrylamide gel as described previously. Maniatis et al., Molecular Cloning: A Laboratory Manual, 1982, Cold Spring Harbor Press. After electrophoresis, the proteins were transferred to nitrocellulose (Bio-Rad Laboratories, Hercules, CA) by electrotransfer using a Bio-Rad transfer apparatus per manufacturer's instructions. The transfer was performed in 25 mM Tris-HCl buffer, containing 0.2 M glycine and 20% methanol, for 45 minutes at 50V with constant current.

FIPV N and E1 proteins were visualized on the nitrocellulose filter using specific antibodies. Davis et al., Basic Methods in Molecular Biology, 1986, Elsevier Science Publishing Company, New York, NY. The filter was rinsed in phosphate buffered saline pH 7.4 containing 0.1% Tween-20 ("PBS-TW"), after which non-specific sites were blocked by overnight incubation at 4°C in PBS containing 1 % bovine serum albumin (PBS-BSA) followed by a 15 min wash in PBS-TW. The filter was then incubated for 30 min at room temperature with anti-FIPV antibodies, which consisted of ascites fluid from a FIPV (strain 79-1146)-infected cat, diluted 1:100 in PBS-TW containing 1% BSA ("PBS-TW-BSA"). After four 5 min washes in PBS-TW, the filter was incubated for 30 min at room temperature with a secondary antibody consisting of biotin-labeled mouse anti-cat IgG antibody (Kirkegaard & Perry Laboratories Inc., Gaithersburg, MD) that had been diluted 1:2000 in PBS-TW-BSA, followed by four 5 min washes in PBS-TW. The filter was then incubated for 30 min at room temperature with horseradish peroxidase-conjugated streptavidin (Kirkegaard & Perry Laboratories Inc.) that had been diluted 1:1000 in PBS-TW. After the filter was washed four times (5 min each) in PBS-TW, the antigen-antibody complexes were visualized with peroxidase chromogenic substrate (Kirkegaard & Perry Laboratories Inc.). Sucrose-gradient purified FIPV and wild-type raccoon pox virus-Vero cell lysates were used as the positive and negative controls, respectively. A typical immunoblot is shown in Figure 6.

7. Raccoon Poxvirus Titration

Serial tenfold dilutions of virus are prepared in MEM and inoculated in replicates of five onto Vero cells (1 x 10⁴ cells per well) in a 96- well plate. Virus preparations may be pretreated by dilution into an equal volume of 0.5% trypsin and incubation at 37°C for 30 min in order to release virus from inclusions. Plates are incubated for 3-5 days at 37°C (5% CO₂) and observed for cytopathology typical of raccoon poxvirus. Titers are calculated as 50% endpoints based on cytopathology using the methods of Reed and Muench, The American Journal of Hygiene 27(3):493-497 (1938).

Example 2

PREPARATION OF VACCINE AND TESTING FOR EFFICACY IN CATS

1. Preparation of Master Seeds of RRPV-FIPV N and E1 Viruses

A single clone of each recombinant virus was selected for large-scale expansion to serve as a master seed virus. The criteria for selection were: 1) Demonstration of purity. Polymerase chain reaction was utilized to insure that the clone was uncontaminated with wild type virus. 2) Demonstration of adequate recombinant protein expression by Western blot or other antigen detection methods.

All recombinant virus expansions and titrations were done on Vero cells in MEM containing 2.5% FBS. Each plaque purified virus clone was expanded by inoculating a confluent monolayer of Vero cells in a 150 cm² flask (1 X 10⁷ cells) with 1 ml of viral-cell lysate (approximately 10⁷ infectious virus particles), and incubating at 37°C (5% CO₂) until 100% cytopathic effect was observed (2-3 days). This virus-cell lysate was titrated on Vero cells as described in Example 1, and served as a premaster seed virus stock to obtain the master

seed virus. The MOI to be used to produce the highest titer master seed virus was determined by inoculating a confluent monolayer of Vero cells in a roller bottle (1×10^8 cells) with various MOIs of recombinant virus (e.g. 0.1, 0.05, 0.01, 0.005, and 0.001 $\text{TCID}_{50}/\text{cell}$.) The infected cells were incubated at 37°C until greater than 80% CPE was observed (approximately 3 days), and the titers of each infected roller bottle was determined. The master seed viruses were aliquoted into 1.5 ml ampules, which were sealed and stored in a liquid nitrogen freezer.

2. Preparation of Vaccines

3×10^7 Vero cells were seeded into 850 cm^2 roller bottles in 200 ml of growth media (MEM containing 0.5% lactalbumin hydrolysate and 5% FBS) and incubated for 18 hours at 37°C . The next day, the medium was removed from the cells and replaced with 50 ml of RRPV-FIPV N virus diluted to an MOI of 0.01 in infection media (MEM containing 0.5% lactalbumin hydrolysate and 2.5% FBS). The virus used was at the second passage beyond the master seed preparation. Virus was allowed to absorb to the cells for 30 min at 37°C , after which the volume of medium was adjusted to 150 ml per roller bottle. Roller bottles were incubated at 37°C until 100% cytopathology was evident (3 days). The virus-cell lysate was harvested and stored frozen (-70°C). The virus titer was determined to be $10^{6.97} \text{TCID}_{50}/\text{ml}$.

RRPV-FIPV E1 stocks were prepared in the same manner, except that an MOI of 0.1 was used. The final virus preparation was titered and found to contain $10^{6.5} \text{TCID}_{50}/\text{ml}$. Wild type raccoon poxvirus was grown using the same methods as described above, and contained $10^{8.44} \text{TCID}_{50}/\text{ml}$.

3. Vaccination

A group of twenty-four 9-month-old cats (specific pathogen-free, Harlan Sprague Dawley, Madison, WI), comprising seven males and seventeen females, was used to demonstrate the efficacy of the RRPV-FIPV N vaccine. Cats were divided into five groups and vaccinated twice, 21 days apart, as indicated below:

Group	# Cats	Vaccine	Volume (ml)	Viral Dose (TCID_{50})	Vaccination Route*
1	5	RRPV-FIPV N	3	$10^{7.44}$	SC
2	5	RRPV-FIPV N	1	$10^{6.97}$	IM
3	5	RRPV-FIPV N	3	$10^{7.44}$	ORAL
4	4	RRPV-FIPV N (1:10 Dilution)	3	$10^{6.44}$	SC
5	5	Wild Type RPV	3	$10^{6.44}$	SC

*SC = Subcutaneous

IM = Intramuscular

Oral = Oral

4. Challenge

Two weeks following the second vaccination, cats were orally inoculated with $10^{3.4} \text{TCID}_{50}$ of Feline Enteric Coronavirus (strain 79-1683, ATCC VR-989). This virus induces a subclinical infection which can enhance subsequent FIPV infection. Three weeks later, cats were orally challenged with $10^{3.4} \text{TCID}_{50}$ of FIPV (strain 79-1146, ATCC VR-990). Cats were monitored weekly for a total of 64 days after challenge for signs of clinical disease including: fever, icterus, leukopenia, anemia, weight loss, anorexia, depression, dehydration, and peritoneal swelling. Cats deemed moribund were euthanized by the attending veterinarian and post-mortem pathological examination was performed. Clinical disease signs were scored as follows:

SIGN**SCORE**

5	Fever	103.0 - 103.9°F	1 point/day*
		104.0 - 104.9°F	2 points/day
		≥105.0°F	3 points/day

*For cats with baseline temperatures averaging 103°F, no points will be scored until temperatures are in excess of 1°F above baseline.

15	Dehydration		1 point/day
	Depression		1 point/day
	Anorexia		1 point/day
	Peritoneal Swelling		1 point/day
	Icterus		1 point/day
20	Weight Loss	>20%	1 point per observation
		>30%	2 points per observation
		>50%	5 points per observation
25	Leukopenia	decrease of 50%	3 points per observation
		counts <6000	2 points per observation
30	Hematocrit	<25% PCV	3 points per observation
	Death		25 points

5. Evaluation of Induced Immunity to FIPV

Inoculation with virulent FIPV induced a fatal infection in 4/5 (80%) of the control cats, which were vaccinated with wild type raccoon poxvirus (Table 1). Both effusive and non-effusive forms of the disease were noted in the control cats. On the other hand, clinical disease was essentially absent after challenge of the subcutaneous vaccinates. The sporadic fever in these cats could be attributed to excitability and the slight anemia on one day in cat 1264 is not a significant finding. The subcutaneous vaccinates showed a statistically significant reduction in clinical signs ($p < 0.05$, by ANOVA) and death ($p < 0.01$, by Chi Square Analysis) when compared to the control cats.

The intramuscular route of vaccination was less effective in that 2/5 (40%) of the cats succumbed to FIPV-induced disease. However, the onset of disease in these cats was delayed when compared to the controls. The decreased efficacy may be related to the lower titer of virus inoculated into these cats because only a 1 ml dose could be administered by this route. There was also decreased efficacy when cats were inoculated by the oral route (60% mortality) which may indicate the need for a higher virus dose when vaccinated by this route.

The protection conferred against FIPV-caused disease by the subcutaneously administered vaccine was shown to be dose-dependent, confirming the benefit of a high-titer RRPV-FIPV vaccine in inducing protection against clinical disease induced by FIPV virus. A suitable vaccine dose contains viral antigen in the range of 10^4 - 10^8 TCID₅₀/ml, preferably 10^7 - 10^8 TCID₅₀/ml. A typical dose for administration to cats is 1-3 ml, and delivery by the subcutaneous route is preferred.

Table 1
TOTAL CLINICAL SCORES FOLLOWING CHALLENGE WITH FIPV

CAT ID	Fever	Weight Loss	Leukopenia	Anemia	Chemical Signs	Death*	Total Score
SUBCUTANEOUS VACCINATES							
1260	0	0	0	0	0	0	0
1262	1	0	0	0	0	0	1
1264	1	0	0	0	0	0	4
1266	0	0	0	0	0	0	0
1268	2	0	0	0	0	0	2
INTRAMUSCULAR VACCINATES							
1270	13	6	0	0	33	26	77
1272	2	0	0	0	0	0	2
1287	23	0	0	0	34	26	81
1288	3	0	0	0	1	0	4
1301	3	0	0	0	0	0	3
ORAL VACCINATES							
1303	1	0	4	0	0	0	6
1305	0	1	0	0	6	0	6
1307	3	1	0	0	4	26	33
1309	2	1	6	0	6	26	40
1311	4	3	0	0	18	26	60
1/10 DOSE SUBCUTANEOUS VACCINATES							
1313	29	6	9	3	36	26	107
1315	17	0	0	0	20	26	82
1317	3	0	3	0	8	26	40
1319	1	0	0	0	0	0	7
CONTROLS							
1321	39	3	18	3	63	26	161
1323	6	0	2	0	14	26	46
1327	0	1	2	0	15	26	43
1329	6	1	6	0	11	26	48
1337	1	0	0	0	0	0	1

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SEQUENCE LISTING

(1) GENERAL INFORMATION:

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(i) APPLICANT: Wasmoen, Terri
Chavez, Lloyd
Chu, Hsien-Jue

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(ii) TITLE OF INVENTION: Recombinant Raccoon Pox Viruse and Their
Use as an Effective Vaccine Against Infectious Peritonitis
Virus Disease

(iii) NUMBER OF SEQUENCES: 4

(iv) CORRESPONDENCE ADDRESS:

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(A) ADDRESSEE: Darby & Darby PC
(B) STREET: 805 Third Avenue
(C) CITY: New York
(D) STATE: New York
(E) COUNTRY: US
(F) ZIP: 10022

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(v) COMPUTER READABLE FORM:

(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.25

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(vi) CURRENT APPLICATION DATA:

(A) APPLICATION NUMBER: US 08/125,516
(B) FILING DATE: 22-SEP-1993
(C) CLASSIFICATION:

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(viii) ATTORNEY/AGENT INFORMATION:

(A) NAME: Schaffer, Robert
(B) REGISTRATION NUMBER: 31,194
(C) REFERENCE/DOCKET NUMBER: 9632/08669

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(ix) TELECOMMUNICATION INFORMATION:

(A) TELEPHONE: 212-527-7700
(B) TELEFAX: 212-753-6237
(C) TELEX: 236687

(2) INFORMATION FOR SEQ ID NO:1:

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(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 789 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: double
(D) TOPOLOGY: linear

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(ii) MOLECULE TYPE: cDNA

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(vi) ORIGINAL SOURCE:

(A) ORGANISM: Feline infectious peritonitis virus

(vii) IMMEDIATE SOURCE:

(B) CLONE: FIPV E1

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

ATGAAGTACA TTTTGCTAAT ACTGGGTCG ATAATGTCAT GGGTTTATGG TGAAGGCTAC	60
TGTGCCATGC AAGACAGTGG CTTCAGTGT ATTAATGGCA CAAATTCAG ATGTCAAACC	120
TGCTTTGAAC GTGGTATCT TATTGGCAT CTGCTAACT GGAACCTCAG CTGGTCTGTA	180
ATATTGATTG TTTTATAAC AGTGTACAA TATGGCAGAC CACAATTAG CTGGCTGGT	240
TATGGCATTA AAATGCTGAT CATGTGGCTA TTATGGCTA TTGTCTAGC GCTTAAGATT	300
TTTAATGCAT ACTCTGAGTA CCAAGTTCC AGATAATGTA TGTTOGGCTT TAGTGTGCA	360
GGTGCACTTG TAAAGTTGC ACTTTGGATG ATGTATTTG TGAGATCTGT TCAGCTATAT	420
AGAGGAACCA AATCATGGTG GTCTTTTAAT CCTGAGACTA ATGCAATTCT TTGTGTTAAT	480
GCAATGGGTA GAAGTTATGT GCTTCCCTA GATGGTACTC CTACAGGTGT TACCCCTACT	540
CTACTTTCAG GAAATCTATA TGCTGAAGGT TTCAAAATGG CTGGTGGTTT AACCATOGAG	600
CATTGGCTA AATAGTCAT GATTGCTACA CCTAGTAGAA CCATGGTTTA TACATTAGTT	660
GGAAACAAAT TAAAGCAAC TACTGCCACA GGATGGGCTT ACTAAGTAA ATCTAAAGCT	720
GGTGATTACT CAACAGAGC ACGTACTGAC AATTGAGTG AACATGAAA ATTATTACAT	780
ATGGTGTA	789

(2) INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 1134 base pairs

(B) TYPE: nucleic acid

(C) STRANDEDNESS: double

(D) TOPOLOGY: linear

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(ii) MOLECULE TYPE: cDNA

(vi) ORIGINAL SOURCE:

(A) ORGANISM: Feline infectious peritonitis virus

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(vii) IMMEDIATE SOURCE:

(B) CLONE: FIPV N

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

ATGGCCACAC AGGGACACG CGTCAACTGG GGAGATGAAC CTTCCAAAAG ACGTGGTGGT 60
 TCTAACTCTC GTGGTCGGAA GAATAATGAT ATACCTTTGT CATTCTACAA CCCATTACC 120
 CTOGAACAAG GATCTAAATT TTGGAATTTA TGTCOGAGAG ACCTTGTTCC CAAAGGAATA 180
 GGTAAATAAGG ATCAACAAAT TGGTTATTGG AATAGACAGA TTCGTTATCG TATTGTAAAA 240
 GGCCAGCGTA AGGAACTCGC TGAGAGGTGG TTCTTTTACT TCTTAGGTAC AGGACCTCAT 300
 GCTGATGCTA AATTCAAAGA CAAGATTGAT GGAGTCTTCT GGGTTGCAAG GGATGGTGCC 360
 ATGAACAAGC CCACAACGCT TGGCACTCGT GGAACCAATA ACGAATCCAA ACCACTGAGA 420
 TTTGATGGTA AGATACCGCC ACAGTTTCAG CTTGAAGTGA ACGTTCTAG GAACAATTCA 480
 AGGTCRGGTT CTCAGTCTAG ATCTGTTTCA AGAAACAGAT CTCAATCTAG AGGAAGACAC 540
 CATTCCAATA ACCAGAATAA TAATGTTGAG GATACAATTG TAGCOGTGCT TGAAAAATTA 600
 GGTGTTACTG ACAACAAGG GTCAAGTTCT AAACCTAGAG AACGTAGTGA TTCCAACCT 660
 AGGGACACAA CACCTAAGAA TGCCAACAA CACACCTGGA AGAAAACGTC AGGCAAGGGA 720
 GATGTGACAA CTTTCTATGG TGCTAGAGT AGTTCAGCTA ACTTTGGTGA TAGTGATCTC 780
 GTTGCCAATG GTAACGCTGC CAAATGCTAC CCTCAGATAG CTGAATGTGT TCCATCAGTG 840
 TCTAGCATAA TCTTTGGCAG TCAATGGTCT GCTGAGAAG CTGGTGATCA AGTGAAAGTC 900
 ACGCTCACTC ACACCTACTA CCTGCCAAG GATGATGCCA AAAGTAGTCA ATTCTAGAA 960
 CAGATTGACG CTTACAAGCG ACCTTCTGAA GTGGCTAAGG ATCAGAGGCA AAGAAGATCC 1020
 CGTTCTAAGT CTGCTGATAA GAAGCCTGAG GAGTTGTCTG TAACTCTTGT GGAGGCATAC 1080
 ACAGATGTGT TTGATGACAC ACAGGTTGAG ATGATTGATG AGGTTACGAA CTAA 1134

(2) INFORMATION FOR SEQ ID NO:3:

- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 8710 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: double
 (D) TOPOLOGY: circular
 (ii) MOLECULE TYPE: DNA (genomic)
 (vi) ORIGINAL SOURCE:
 (A) ORGANISM: Feline infectious peritonitis virus
 (vii) IMMEDIATE SOURCE:

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(B) CLONE: psc11f1

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

10	CGAAGGGCC TCGTGATACG CCTATTTTTA TAGGTTAATG TCATGATAAT AATGGTTTCT	60
	TAGACGTCAG GTGGCACITTT TCGGGGAAT GTGCGCGAA CCCCTATTG TTTATTTTTC	120
	TAAATACATT CAAATATGTA TCOGCTCATG AGACAATAAC CCTGATAAAT GCTTCAATAA	180
15	TATTGAAAAA GGAAGAGTAT GAGTATTCAA CATTTCCGTG TCGCCCTTAT TCCCTTTTTT	240
	GCGGCATTTT GCCTTCCTGT TTTTGCTCAC CCAGAAAAGC TGGTGAAAGT AAAAGATGCT	300
	GAAGATCAGT TGGGTGCACG AGTGGGTTAC ATCGAACTGG ATCTCAACAG CGGTAAGATC	360
20	CTTGAGAGTT TCGCCCGA AGAAGTTTT CCAATGATGA GCACTTTAA AGTTCGCTA	420
	TGTGGCGCGG TATTATCCCG TATTGAAGCC GGGCAAGAGC AACTCGGTG CCGCATACAC	480
	TATCTCAGA ATGACTTGGT TGAGTACTCA CCAGTCACAG AAAAGCATCT TACGGATGGC	540
25	ATGACAGTAA GAGAATTATG CAGTGCTGCC ATAACCATGA GTGATAACAC TCGGCGCAAC	600
	TTACTTCTGA CAAAGATGCG AGGACCGAAG GAGCTAACCG CTTTTTTCGA CAACATGGGG	660
	GATCATGTAA CTGCGCTTGA TCGTTGGGAA CGGAGCTGA ATGAAGCCAT ACCAAGCGAC	720
30	GAGCGTGACA CCACGATGCC TGTAGCAATG GCAACAACGT TCGGCAACT ATTAAGTGGC	780
	GAACACTTA CTCTAGCTTC CCGGCAACAA TTAATAGACT GGATGGAGGC GGATAAAGTT	840
	GCAGGACCAC TTCTGCGCTC GGCCCTTCOG GCTGGCTGGT TTATTGCTGA TAAATCTGGA	900
35	GCGGCTGAGC GTGGGTCTOG CGGTATCATT GCAGCACTGG GGCCAGATGG TAAGCCCTCC	960
	OGTATCGTAG TTATCTACAC GACGGGGAGT CAGGCAACTA TGGATGAACG AAATAGACAG	1020
	ATOGCTGAGA TAGGTGCCTC ACTGATTAG CATTTGTAAC TGTGAGACCA AGTTTACTCA	1080
40	TATATACTTT AGATTGATTT AAAACTTCAT TTTTAATTTA AAAGGATCTA GGTGAAGATC	1140
	CTTTTTGATA ATCTCATGAC CAAAATCCCT TAACTGAGT TTCTGTTCCA CTGAGGCTCA	1200
	GACCCCGTAG AAAAGATCAA AGGATCTTCT TGAGATCCTT TTTTCTGCG CGTAATCTGC	1260
	TGCTTGCAAA CAAAAAACC ACGCTACCA GCGTGTTTT GTTTGCCGGA TCAAGAGCTA	1320
45	CCAACCTTTT TCCGAAGGT AACTGGCTTC AGCAGAGCGC AGATACCAA TACTGTCTTT	1380
	CTAGTGTAGC CGTAGTTAGG CCACCACTTC AAGAACTCTG TAGCACCGCC TACATACCTC	1440
50	GCTCTGCTAA TCCGTTACC AGTGGCTGCT GCAGTGGCG ATAAGTGTG TCTTACGGG	1500

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5	TTGGACTCAA	GAAGATAGTT	ACCGGATAAG	GCGCAGCGGT	CGGGCTGAAC	GGGGGGTTGG	1560
	TGCACACAGC	CCAGCTTGGA	GOGAAGGACC	TACACOGAAC	TGAGATACCT	ACAGCGTGAG	1620
10	CATTGAGAAA	GCGCCACGCT	TCCOGAAGGG	AGAANGGCGG	ACAGGTATCC	GGTAAGCGGC	1680
	AGGGTCGGAA	CAGGAGAGCG	CACGAGGGAG	CTTCCAGGGG	GAAACGCCCTG	GTATCTTTAT	1740
	AGTCCTGTGG	GGTTTCGCCA	CCTCTGACTT	GAGCGTGGAT	TTTTGTGATG	CTCGTCAGGG	1800
15	GGGCGGAGCC	TATGGAAGAA	CGCCAGCAAC	GCGGCCCTTT	TACGGTTCCT	GGCCTTTTGC	1860
	TGGCCTTTTG	CTCACATGTT	CTTTCCTGGG	TTATCCCGTG	ATTCTGTGGA	TAAACGTATT	1920
	ACCGCCTTTG	AGTGAGCTGA	TACCGCTGCG	CGCAGCGGAA	CGACCGAGCG	CAGCGAGTCA	1980
20	GTGAGCGAGG	AAGCGGAAGA	GCGCCCAATA	CGCAACCGCG	CTCTCCCGCG	GCGTTGGCGG	2040
	ATTCATTAAAT	GCAGCTGGCA	CGACAGGTTT	CCCGACTGGA	AAGCGGGCGG	TGAGCGCAAC	2100
	GCAATTAATG	TGAGTTAGCT	CATCTATTAG	GCACCCCGAG	CTTTACACTT	TATGCTTCCG	2160
25	GCTCGTATGT	TGTGTGGAAT	TGTGAGCGGA	TAACAATTTC	ACACAGGAAA	CAGCTATGAC	2220
	CATGATTACG	CCAAGCTTTT	GCGATCAATA	AATGGATCAC	AACCAGTATC	TCTTAACGAT	2280
	GTCTCTCGCA	GATGATGATT	CATTTTTTAA	GTATTTGGCT	AGTCAAGATG	ATGAAATCTT	2340
30	CATTATCTGA	TATATTGCAA	ATCACTCAAT	ATCTAGACTT	TCTGTTATTA	TTATGTATCC	2400
	AATCAAAAAA	TAAATTAGAA	GCCGTGGGTC	ATTGTTATGA	ATCTCTTTCA	GAGGAATACA	2460
	GACAATTGAC	AAATTCACA	GACTTTCAAG	ATTTTAAAAA	ACTGTTTAAAC	AAGGTCCCTA	2520
35	TTGTTACAGA	TGGAAGGGTC	AAACTTAATA	AAGGATATTT	GTTGACTTTT	GTGATTAGTT	2580
	TGATGCGATT	CAAAAAGAA	TCCTCTCTAG	CTACCACCGC	AATAGATCCT	GTTAGATACA	2640
	TAGATCCTCG	TCGCAATATC	GCATTTTCTA	ACGTGATGGA	TATATTAAGG	TCGAATAAAG	2700
40	TGAACAATAA	TTAATTCTTT	ATTGTCATCA	TGAACGGCGG	ACATATTTCG	TGATAAATCG	2760
	GCCCCATGTT	TTCAGGTAAA	AGTACAGAAT	TAATTAGACG	AGTTAGAGGT	TATCAATAG	2820
	CTCAATATAA	ATGCGTGACT	ATAAAATATT	CTAACGATAA	TAGATACGGA	ACGGGACTAT	2880
45	GGACGCATGA	TAAGAATAAT	TTTGAGGCAT	TGGAAGCAAC	TAAACTATGT	GATCTCTTGG	2940
	AATCAATTAC	AGATTCTCTC	GTGATAGGTA	TCGATGAAGG	ACAGTTCTTT	CCAGACATTG	3000
	TTGAATTCCG	AGCTTGGCTG	CAGGTGGGGG	ATCCCCCTCG	CCCGGTTATT	ATTATTTTTG	3060
50	ACACCAGACC	AACTGGTAAT	GGTAGOGAAC	GCGGCTCAGC	TGAATTCCGC	CGATACTGAC	3120

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 GGGCTCCAGG AGTGGTCGCC ACCAATCCCC ATATGGAAAC CGTCGATATT CAGCCATGTG 3180
 CCTTCTTCGG CGTGCAGCAG ATGGCGATGG CTGGTTTCCA TCAGTTGCTG TTGACTGTAG 3240
 10 CGGCTGATGT TGAATGGAA GTGCGCGGCG CACTGGTGTG GGCCATAATT CAATTGCGGC 3300
 GTCCCGCAGC GCAGACGGTT TTGCTGGGG AAGACGTACG GGGTATACAT GTCTGACAAT 3360
 GGCAGATCCC AGCGGTCAAA ACAGGCGGCA GTAAGGCGGT CGGGATAGTT TTCTTGGGGC 3420
 CCTAATTCGA GCCAGTTTAC CGGCTCTGCT ACCTGGGCGA GCTGGCGATT CAGGCCAATC 3480
 15 CGCGCGGGAT GCGGTGTATC GCTCGCCACT TCAACATCAA CGGTAATGCG CATTTGACCA 3540
 CTACCATCAA TCGGTAGGT TTTCCGGCTG ATAAATAAGG TTTTCCCCTG ATGCTGCCAC 3600
 GCGTGACCGG TGTAAATCAG CACCGCATCA GCAAGTGTAT CTGCGGTGCA CTGCAACAAC 3660
 20 GCTGCTTCGG CCTGGTAATG GCGCGCGGCC TTCCAGCGTT CGACCCAGGC GTTAGGGTCA 3720
 ATGCGGGTGG CTTCACTTAC GCCAATGTGG TTATCCAGCG GTGCAAGGTT GAACTGATCG 3780
 CGCAGCGGCG TCAGCACTTG TTTTTTATCG CCAATCCACA TCTGTGAAG AAAGCCTGAC 3840
 25 TGGCGGTAA ATTGCCAAAG CTTATTACCG AGCTCGATGC AAAAATCCAT TTGCTGGTG 3900
 GTCAGATGCG GGATGGCGTG GGACGCGGCG GGGAGCGTCA CACTGAGGTT TCGCGCCAGA 3960
 CGCCACTGCT GCCAGGCGCT GATGTGCGCG GCTTCTGACC ATGCGGTGCG GTTCGGTTGC 4020
 30 ACTACGGTGA CTGTGAGCCA GAGTTGCCCG GCGCTCTCG GCTGCGGTAG TTCAGGCAGT 4080
 TCAATCAACT GTTTACCTTG TGGAGCGACA TCCAGAGGCA CTTCAAGGCT TGCCAGGGC 4140
 TTACCATCCA GCGCCACCAT CCACTGCAGG AGCTCGTTAT CGCTATGACG GAACAGGTAT 4200
 TOGCTGGTCA CTTGGAATGGT TTGCCCGGAT AAACGGAACT GGAAAAACTG CTGCTGGTGT 4260
 35 TTTGCTTCGG TCAGCGCTGG ATGCGGGGTG CGGTGCGCAA AGACCAGACC GTTCATACAG 4320
 AACTGGCGAT CGTTGGGGT ATCGCCAAAA TCACGCGCGT AAGCCGACCA CGGGTTGCGG 4380
 TTTTCATCAT ATTTAATCAG CGACTGATCC ACCCAGTCCC AGACGABGCC GCGCTGTAAA 4440
 40 CGGGGATACT GACGAAACGC CTGCCAGTAT TTAGCGAAAC CGCCAAGACT GTTACCCATC 4500
 GCGTGGGGGT ATTOGCAAG GATCAGGGG CGCGTCTCTC CAGGTAGOGA AAGCCATTTT 4560
 TTGATGGACC ATTTGGGCAC AGCGGGGAAG GGCTGGTCTT CATCCAGCG GCGTACATC 4620
 45 GGGCAAATAA TATCGGTGGC CGTGGTGTGG GCTCGCGCGC CTTCACTATG CACCGGGGCG 4680
 GAAGGATCGA CAGATTTGAT CCAGCGATAC AGCGCGTGGT GATTAGOGCC GTGGCCTGAT 4740

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5	TCATTCCOCA GOGACCAGAT GATCACACTC GGGTGATTAC GATOGGCGTG CACCATTOGC	4800
	GTTAOCGOTT CGCTCATCGC CGGTAGCCAG CGGGATCAT CGGTGAGAG ATTGATTGGC	4860
	ACCATGCCGT GGGTTTCAAT ATTGGCTTCA TCCACCACAT ACAGGCGTA GGGTTCGCAC	4920
10	AGCGTGTACC ACAGCGGATG GTTCGGATAA TGCGAACAGC GCACGGCGTT AAAGTTGTTC	4980
	TGCTTCATCA GCAGGATATC CTGCACCATC GTCTGCTCAT CCATGACCTG ACCATGCAGA	5040
	GGATGATGCT CGTGACGGTT AAGCCCTCGA ATCAGCAACG GCTTGCCTTT CAGCAGCAGC	5100
15	AGACCATTTT CAATCCGCAC CTGCGGAAA CGACATCGC AGGCTTCTGC TTCAATCAGC	5160
	GTGCCGTGG CGGTGTGCAG TTCAACCACC GCACGATAGA GATTGGGGAT TTOGGGCTC	5220
	CACAGTTTTC GGTPTTCGAC CTTGAGAAGT AGTGTGACGC GATCGGCATA ACCACCACGC	5280
20	TCATCGATAA TTTCACCGCC GAAAGGCGCG GTGCGGCTGG CGACCTGCGT TTCACCTGC	5340
	CATAAAGAAA CTGTTACCG TAGGTAGTCA CGCAACTCGC CGCACATCTG AACTTCAGCC	5400
	TCCAGTACAG CGCGCTGAA ATCATCATT AAGCGAGTGG CAACATGGAA ATCGCTGATT	5460
25	TGTGTAGTGG GTTTATGCAG CAACGAGAGC TCAAGGAAA TGCGGCTCAT CGGCCACATA	5520
	TCTGTATCTT CCAGATAACT GCGTCACTC CAACGCAGCA CCATCACCGC GAGGCGGTTT	5580
	TCTCGGCGC GTAAAAATGC GCTCAGGTCA AATTGAGAG GCAAAAGACT GTCTGGGCG	5640
30	TAACCGACCC AGCGCCCGTT GCACCACAGA TGAAACGCG AGTTAACGCC ATCAAAAATA	5700
	ATTGCGGTCT GGCTTCTCTG TAGCCAGCTT TCATCAACAT TAAATGTGAG CGAGTAACAA	5760
	CCCGTCGGAT TCTCGGTGGG AACAAACGCG GGATTGACCG TAATGGGATA GGTTCAGTTG	5820
35	GTGTAGATGG GCGCATCGTA ACOGTGCATC TGCCAGTTTG AGGGGACGAC GACAGTATCG	5880
	GCCTCAGGAA GATCGCACTC CAGOCAGCTT TCCGGCACCG CTCTGGTGC CGGAAACCAG	5940
	GCAAAGCGCC ATTGCGCATT CAGGCTGCGC AACTGTTGGG AAGGGCGATC GGTGCGGGCC	6000
	TCTTCGCTAT TACGCCAGCT GGCGAAAGGG GGATGTGCTG CAAGGCGATT AAGTTGGGTA	6060
40	ACGCCAGGGT TTTCCAGTC ACGACGTTGT AAAACGACGG GATCCCTCGA GGAATTCATT	6120
	TATAGCATAG AAAAAACAA AATGAAATTC TACTATATTT TTACATACAT ATATTCTAAA	6180
	TATGAAAGTG GTGATTGTGA CTAGCGTAGC ATCGCTTCTA GACATATACT ATATAGTAAT	6240
45	ACCAATACTC AAGACTACGA AACTGATACA ATCTCTTATC ATGTGGGTAA TGTTCOGAT	6300
	GTCGAATAGC CATATGCGCG TAGTTGCGAT ATACATAAAC TGATCACTAA TTCCAAACCC	6360

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ACCCGCTTTT TATAGTAAGT TTTTCACCCA TAAATAATAA ATACAATAAT TAATTTCTCG 6420
 TAAAAGTAGA AAATATATTC TAATTTATTG CACGGTAAGG AAGTAGAATC ATAAAGAACA 6480
 GTGACGGATC CCAATTGGG CATTTTGGT TTGAATAAA CAAATGAAG TACATTTTGC 6540
 TAATACTGGC GTGCATAATT GCATGOGTTT ATGGTGAACG CTACTGTGCC ATGCAAGACA 6600
 GTGGCTTGCA GTGTATTAAAT GGCACAAATT CAAGATGTCA AACCTGCTTT GAACTGGGTG 6660
 ATCTTATTTG GCATCTTGCT AACTGGAACT TCAGCTGGTC TGTAAATATTG ATTGTTTTTA 6720
 TAACAGTGTG ACAATATGGC AGAACCACAT TTAGCTGGCT CGTTTATGGC ATTAAAATGC 6780
 TGATCATGTG GCTATTATGG CCTATTGTTT TAGOGCTTAC GATTTTTAAT GCATACTCTG 6840
 AGTACCAAGT TTCCAGATAT GTAATGTTTG GCTTTAGTGT TGCAGGTGCA GTTGTAAAGT 6900
 TTGCACTTTG GATGATGTAT TTTGTGAGAT CTGTTAGCT ATATAGAAGA ACCAAATCAT 6960
 GGTGGTCTTT TAATCCTGAG ACTAATGCAA TTCTTTGTGT TAATGCATTG GGTAGAAGTT 7020
 ATGTGCTTCC CTAGATGGT ACTCCTACAG GTGTACCTT TACTCTACTT TCAGGAAATC 7080
 TATATGCTGA AGGTTTCAA ATGGCTGGTG GTTTAACCAT CGAGCATTG CCTAATAACG 7140
 TCATGATTGC TACACCTAGT AGAACCATCG TTTATACATT AGTTGGAAAA CAATTAAAAG 7200
 CAACTACTGC CACAGGATGG GCTTACTACG TAAATCTAA AGCTGGTGAT TACTCAACAG 7260
 AAGCACGTAC TGACAATTTG AGTGAACATG AAAAATTATT ACATATGGTG TAACTAAACT 7320
 TTCAAATGGG GGAATTCGT GAGGTATCG CAAAGGAAGG AAAAATTAGT TATAGTAGCC 7380
 GCACTOGATG GGACATTTCA ACGTAAACCG TTTAATAATA TTTTGAATCT TATTCCATTG 7440
 TCTGAAATGG TGGTAAACT AACTGCTGTG TGTATGAAAT GCTTTAAGGA GGCTTCCTTT 7500
 TCTAAACGAT TGGGTGAGGA AACCGAGATA GAAATAATAG GAGGTAAATG TATGTATCAA 7560
 TGGGTGTGTA GAAAGTGTTA CATCGACTCA TAATATTATA TTTTTATCT AAAAAACTAA 7620
 AAATAACAT TGATTAAATT TTAATATAAT ACTTAAAAAT GGATGTTGTG TCGTTAGATA 7680
 AACGTTTAT GTATTTTGAG GAAATTGATA ATGAGTTAGA TTACGAACCA GAAAGTGCAA 7740
 ATGAGGTGCG AAAAAAATG CGTATCAAG GACAGTTAAA ACTATTACTA GGAGAATTAT 7800
 TTTTCTTAG TAAGTTACAG CGACAGGTA TATTAGATGG TGCCACGTA GTGTATATAG 7860
 GATCTGCTCC CGGTACACAT ATACGTTATT TGAGAGATCA TTTCTATAAT TTAGGAGTGA 7920
 TCATCAAATG GATGCTAATT GACGGCCGCC ATCATGATCC TATTTTAAAT GGATTGCGTG 7980

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ATGTGACTCT AGTGACTCGG TTGTTTGATG AGGAATATCT ACGATCCATC AAAAAACAAC 8040
 TGCATCCTTC TAGGATTATT TTAATTTCTG ATGTGAGATC CAAACGAGGA GGAAATGAAC 8100
 10 CTAGTACGGC GGATTTACTA AGTAATTACG CTCTACAAA TGTCATGATT AGTATTTTAA 8160
 ACCCCGTGGC GTCTAGTCTT AAATGGAGAT GCCCGTTTCC AGATCAATGG ATCAAGGACT 8220
 TTATATATCC ACACGGTAAT AAAATGTTAC AACCTTTTGC TCCTTCATAT TCAGGGCCGT 8280
 15 CGTTTACAA CGTCGTGACT GGGAAAACCC TGGCGTTACC CAACTTAATC GCGTTGCAGC 8340
 ACATCCCCCT TTGCCAGCT GGCGTAATAG CGAGAGGCC GGCACGATC GCGCTTCCCA 8400
 ACASTTGCGC AGCCTGAATG GCGAATGGCG CCTGATGCGG TATTTTCTCT TTAAGCATCT 8460
 GTGCGGTATT TCACACGCA TATGGTGCAC TCTCAGTACC ATCTGCTCTG ATGCGGCATA 8520
 20 GTTAAGCCAG TACACTCGC TATCGCTACG TGACTGGGTC ATGGCTGGC CCGACACCC 8580
 GCCAACACCC GCTGACGCGC CCTGACGGGC TTGTCGCTC CGGCATCCG CTTACAGACA 8640
 AGCTGTGACC GTCTCGGGA GCTGCATGTG TCAGAGGTTT TCACCGTCAT CACOGAAACG 8700
 25 CGGAGGCAG 8710

(2) INFORMATION FOR SEQ ID NO:4:

- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 9019 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: double
 (D) TOPOLOGY: circular
 (ii) MOLECULE TYPE: DNA (genomic)
 35 (vi) ORIGINAL SOURCE:
 (A) ORGANISM: Feline immunodeficiency virus
 (vii) IMMEDIATE SOURCE:
 (B) CLONE: psc11e1

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

GAAAGGGCCT CGTGATAQGC CTATTTTAT AGGTTAATGT CATGATAATA ATGGTTTCTT 60
 AGACGTCAGG TGGCACTTTT CGGGGAAATG TGCGCGGAAC CCTATTGTGT TTATTTTCTT 120
 45 AAATACATT CAAATATGTAT CGCTCATGA GACAATAACC CTGATAAATG CTTCAATAAT 180
 ATTGAAAAAG GAAGAGTATG AGTATTCAAC ATTTTCGTGT CGCCCTTATT CCGTTTTTTG 240
 CGGCATTTTG CCTTCCTGTT TTTGCTCACC CAGAAACGCT GGTGAAAGTA AAGATGCTG 300

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	AAGATCAGTT GGGTGCACGA GTGGGTACCA TCGAACTGGA TCTCAACAGC GGTAAAGATCC	360
	TTGAGAGTTT TCGCCCOGAA GAACGTTTTT CAATGATGAG CACTTTTAAA GTTCTGCTAT	420
10	GTGGGCGCGT ATTATCCCGT ATTGAOCCCG GGCAGAGCA ACTGGTGGC CGCATACACT	480
	ATTCTCAGAA TGAATTGGTT GAGTACTCAC CAGTCACAGA AAGCATCTT ACGGATGGCA	540
	TGACAGTAAG AGAATTATGC AGTGTGCGCA TAACCATGAG TGATAACACT GCGGCCAACT	600
15	TACTTCTGAC AACGATOGGA GGACCGAAGG AGCTAACCGC TTTTGTGCAC AACATGGGGG	660
	ATCATGTAAC TCGCCTTGAT CGTTGGGAAC CGGAGCTGAA TGAAGCCATA CCAAGCGACG	720
	AGCGTGACAC CACGATGCGT GTAGCAATGG CAACAACGTT GCGCAAACTA TTAAGTGGCG	780
	AACTACTTAC TCTAGCTTCC CGGCAACAAT TAATAGACTG GATGGAGGGG GATAAAGTTG	840
20	CAGGACCACT TCTGCGCTCG GCGCTTCGG CTGGCTGGTT TATTGCTGAT AAATCTGGAG	900
	CGGCTGAGCG TGGGTCTGGC GGTATCATTG CAGCACTGGG GCCAGATGGT AAGCCCTCCC	960
	GTATCGTAGT TATCTACAG ACGGGGAGTC AGGCAACTAT GGATGAACGA AATAGACAGA	1020
25	TOGCTGAGAT AGGTGCGTCA CTGATTAAAG ATTGGTAACT GTCAGACCAA GTTTACTCAT	1080
	ATATACTTTA GATTGATTTA AAACCTTCAT TTTAATTTAA AAGGATCTAG GTGAAGTCC	1140
	TTTTTGATAA TCTCATGAC AAAATCCCTT AACGTGAGTT TCGTTCCAC TGAGCGTCAG	1200
30	ACCCCGTAGA AAAGATCAAA GGATCTTCTT GAGATCCCTT TTTCTGGGC GTAATCTGCT	1260
	GCTTGCAAC AAAAAACCA CGCTACCG CGGTGGTTTG TTTGCGGAT CAAGAGCTAC	1320
	CAACTCTTTT TCGAAGGTA ACTGGCTTCA GCAGAGCGCA GATACCAAAT ACTGTCTTTC	1380
35	TAGTGTAGCC GTAGTTAGGC CACCACTTCA AGAACTCTGT AGCAGCGCCT ACATACCTCG	1440
	CTCTGCTAAT CCGTTTACCA GTGGCTGCTG CCACTGGGGA TAAGTGTGT CTTACCGGGT	1500
	TGGACTCAAG ACGATAGTTA CGGATAAGG CGCAGCGTC GGGCTGAAG GGGGGTTGTT	1560
40	GCACACAGCC CAGCTTGGAG CGAACGACCT ACACCGAACT GAGATACCTA CAGCGTGAGC	1620
	ATTGAGAAAG CGCCACGCTT CCGAAGGGA GAAAGGCGGA CAGGTATCCG GTAAGCGGCA	1680
	GGGTGGAAC AGGAGAGCGC ACGAGGGAGC TTCCAGGGG AAACGCTGG TATCTTTATA	1740
	GTCTGTGTOG GTTTCGCCAC CTCTGACTTG AGCGTCGATT TTTGTGATGC TGTTCAGGGG	1800
45	GGCGGAGCCT ATGGAAAAAC GCCAGCAACG CGGCCTTTTT ACGGTTCTTG GCCTTTTGCT	1860
	GGCCTTTTGC TCACATGTTT TTTCTGCGT TATCCCTTGA TTCTGTGGAT AACGTATTA	1920

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5	COGCCCTTTGA GTGAGCTGAT ACOGCTCGCC GCAGCCGAAC GACOGAGCGC AGCGAGTCAG	1980
	TCAGCGAGGA AGCGGAAGAG CGCCCAATAC GCAAAACOGC TCTCCCOGCG CGTTGGCCGA	2040
	TTCAATTAATG CAGCTGGCAC GACAGGTTTC COGACTGGAA AGCGGGCAGT GAGCGCAACG	2100
10	CAATTAATGT GAGTTAGCTC ACTCATTAGG CACCCAGGC TTTACACTTT ATGCTTCGG	2160
	CTCGTATGTT GTGTGGAATT GTGAGCGGAT AACAAATTTCA CACAGGAAAC AGCTATGACC	2220
	ATGATTACGC CAAGCTTTTG CGATCAATAA ATGGATCACA ACCAGTATCT CTTAACGATG	2280
15	TTCTTCGCAG ATGATGATTC ATTTTTTAAG TATTTGGCTA GTCAAGATGA TGAAATCTTC	2340
	ATTAATCTGAT ATATTGCAAA TCACTCAATA TCTAGACTTT CTGTTATTAT TATTGATCCA	2400
	ATCAAAAAAT AATTAGAAG CGTGGGTCA TTGTTATGAA TCTCTTTCAG AGGAATACAG	2460
20	ACAATTGACA AAATTCACAG ACTTTCARGA TTTTAAAAA CTGTTTAACA AGGTCCCTAT	2520
	TGTTACAGAT GGAAGGTCA AACTTAATAA AGGATATTG TTCGACTTTG TGATTAGTTT	2580
	GATGCGATTC AAAAAAGAT CCTCTCAGC TACCACOGCA ATAGATCCTG TTAGATACAT	2640
25	AGATCCTCGT CGCAATATCG CATTTTCTAA CGTGATGGAT ATATTAAAGT CGAATAAAGT	2700
	GAACAATAAT TAATTCCTTA TTGTCATCAT GAACGGCGGA CATATTCACT TGATAATCGG	2760
	CCCCATGTTT TCAGGTAAAA GTACAGAATT AATTAGAAGA GTTAGACGTT ATCAAAATAGC	2820
30	TCAATATAAA TGCGTGACTA TAAATATTC TAACGATAAT AGATACGGAA CGGGACTATG	2880
	GAOGCATGAT AAGAATAATT TTGAAGCATT GGAAGCAACT AACTATGTG ATCTCTTGGA	2940
	ATCAATTACA GATTTCTCCG TGATAGGTAT CGATGAAGGA CAGTTCCTTC CAGACATTGT	3000
35	TGAATTCGGA GCTTGGCTGC AGGTGGGGGA TCCCCCTGC COGGTTATTA TTATTTTTGA	3060
	CACCAGACCA ACTGGTAAAG GTAGOGAAG GCGCTCAGCT GAATTCOGCC GATACTGACG	3120
	GGCTCCAGGA GTGCTGCCA CCAATCCCCA TATGGAAACC GTCGATATTC AGCCATGTGC	3180
	CTTCTTCOGC GTGCAGCAGA TGGCGATGGC TGGTTTCCAT CAGTTGCTGT TGACTGTAGC	3240
40	GGCTGATGTT GAACTGGAAG TCGCCGCGCC ACTGGTGTGG GCCATAATTC AATTGCGCGG	3300
	TCCCGCAGCG CAGACGTTT TCGCTCGGGA AGACGTACGG GGTATACATG TCTGACAATG	3360
	GCAGATCCCA GCGGTCAAAA CAGGOGGCG TAAGGOGGTC GGGATAGTTT TCTTGCGGCC	3420
45	CTAATCCGAG CCAGTTTACC CGCTCTGCTA CCTGCGCCAG CTGGCAGTTC AGGCCAATCC	3480
	GOGCGGGATG CGGTGTATCG CTCGCCACTT CAACATCAAC GGTAAATCGCC ATTTGACCAC	3540

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5	TACCATCAAT	COGGTAGGTT	TTCGGGCTGA	TAAATAAGGT	TTTCCCTGTA	TGCTGCCACG	3600
	CGTGACOGGT	CGTAATCAGC	ACCGCATCAG	CAAGTGTATC	TGCGGTGCAC	TGCAACAACG	3660
10	CTGCTTCGGC	CTGGTAATGG	CCCGCCGCCT	TCCAGCGTTC	GACCCAGGCG	TTAGGGTCAA	3720
	TGCGGGTCGC	TTCACTTACG	CCAATGTGCT	TATCCAGCGG	TGCAOGGGTG	AACTGATGCG	3780
	GCAGOGGCGT	CAGCAGTTGT	TTTTTATCGC	CAATCCACAT	CTGTGAAGA	AAGCCTGACT	3840
15	GGCGGTTAAA	TTGCCAAOGC	TTATTACCCA	GCTCGATGCA	AAAATCCATT	TCGCTGGTGG	3900
	TCAGATGCGG	GATGGCGTGG	GACGCGGCGG	GGAGOGTCAC	ACTGAGGTTT	TCOGCCAGAC	3960
	GCCACTGCTG	CCAGGCGCTG	ATGTGCCCGG	CTTCTGACCA	TGCGGTGCGG	TTGGTTTGCA	4020
	CTACGGGTAC	TGTGAGCCAG	AGTTGCCCGG	CGCTCTCGG	CTGCGGTAGT	TCAGGCAGTT	4080
20	CAATCAACTG	TTTACCTTGT	GGAGOGACAT	CCAGAGGCAC	TTACOGCTTT	GCCAGCGGCT	4140
	TACCATCCAG	CGCCACCATC	CAGTGCAGGA	GCTCGTTATC	GCTATGAOGG	AACAGGTATT	4200
	CGCTGGTCAC	TTGATGGTTT	TGCCCGGATA	AACGGAACTG	GAAAAACTGC	TGCTGGTGTG	4260
25	TTGCTTCGGT	CAGCGCTGGA	TGCGGGCTGC	GGTCGGCAAA	GACCAGACCG	TTTATACAGA	4320
	ACTGGCGATC	GTTCGGGGTA	TGCCCAAAT	CACCGCGGTA	AGCCGACCAC	GGGTTGCCGT	4380
	TTTCATCATA	TTTAATCAGC	GACTGATCCA	CCCAGTCCCA	GACCAAGCCG	CCCTGTAAAC	4440
30	GGGGATACTG	ACGAAACGCC	TGCCAGTATT	TAGOGAAACC	GCCAAGACTG	TTACCCATOG	4500
	CGTGGGCGTA	TTGCAAAAGG	ATCAGOGGGG	GCGTCTCTCC	AGGTAGOGAA	AGCCATTTT	4560
	TGATGGACCA	TTTOGGCACA	GCOGGGAAGG	GCTGGTCTTC	ATCCAGCGGC	GCGTACATOG	4620
35	GGCAAATAAT	ATOGGTGGCC	GTGGTGTGGG	CTCCGCGGCC	TTTACTACTG	ACCGGGGCGG	4680
	AAGGATOGAC	AGATTTGATC	CAGCGATACA	GCGCGTGGT	ATTAGOGCGG	TGGCCTGATT	4740
	CATTCCCCAG	CGACCAGATG	ATCACACTOG	GGTGATTACG	ATOGCGCTGC	ACCATTGOGG	4800
40	TTACGGGTTC	GCTCATGGCC	GGTAGCCBGC	GCGGATCATC	GGTCAGAOGA	TTGATTGGCA	4860
	CCATGCGGTG	GGTTTCAATA	TTGGCTTCAT	CCACCACATA	CAGGCCGTAG	CGGTGCGACA	4920
	GCGTGTACCA	CAGOGGATGG	TTCCGATAAT	GCGAACAGOG	CACGGCGTTA	AAGTTGTTCT	4980
45	GCTTCATCAG	CAGGATATCC	TGCACCATOG	TCTGCTCATC	CATGACCTGA	CCATGCAGAG	5040
	GATGATGCTC	GTGACGGTTA	ACGCCTOGAA	TCAGCAAOGG	CTTGCGGTTT	AGCAGCAGCA	5100
	GACCATTTTC	AATCOGCACC	TGCGGGAAC	CGACATGCA	GGCTTCTGCT	TCAATCAGCG	5160

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5	TECCGTGGC GGTGTGCACT TCAACCACCG CAOGATAGAG APTGGGATT TCGGGCTCC	5220
	ACAGTTTCGG GTTTTCGACC TTGAGAGCTA GTGTGACGG ATCGGCATAA CCACCAOCT	5280
	CATOGATAAT TTCACOGCG AABGGGOGGG TCGCGCTGGC GACCTGOGTT TCACCTGCG	5340
10	ATAAAGAAAC TGTTACCGT AGGTAGTCAC GCAACTCGCC GCACATCTGA ACTTCAGCCT	5400
	CCAGTACAGC GCGGCTGAAA TCATCATTAA AGOGAGTGGC AACATGGAAA TOGCTGATTT	5460
	GTGTAGTCGG TTTATGCAGC AACGAGAGT CAOGGAAAAT GCGGCTCATC CGCCACATAT	5520
15	CCTGATCTTC CAGATAACTG CCGTCACTCC AACGAGCAC CATCACCGCG AGGCGGTTTT	5580
	CTCGGCGCG TAAAAATGCG CTCAGGTCAA ATTCAGACGG CAAAGACTG TCCTGGCGGT	5640
	AACGACCCA GCGCCCGTTG CACCACAGAT GAAAGCGGA GTTAAGCCA TCAAAATAA	5700
20	TTGCGTCTG GCCTTCCTGT AGCCAGCTTT CATCAACATT AATGTGAGC GAGTAACAAC	5760
	CGTGGGATT CTCGTGGGA ACAAACGGCG GATTGACGT AATGGGATAG GTTACGTTGG	5820
	TGTAGATGGG CGCATCGTAA CGGTGCATCT GCCAGTTTGA GGGGACGAC ACAGTATCG	5880
25	CCTCAGGAAG ATGCACTCC AGCCAGCTTT CCGCACCGC TTCTGGTGCC GGAAACCAGG	5940
	CAAAGCGCCA TTGCGCTTC AGGCTGCGCA ACTGTGGGA AGGGGATCG GTGGGGCT	6000
	CTTGGCTATT ACGCCAGCTG GCGAAAGGGG GATGTGCTGC AAGGOGATTA AGTTGGGTAA	6060
30	CGCCAGGGTT TTCCAGTCA CGACGTTGTA AAAGACGGG ATCCCTGAG GAATTCTATT	6120
	ATAGCATAGA AAAAAACAAA ATGAAATTCT ACTATATTTT TACATACATA TATTCTAAAT	6180
	ATGAAAGTGG TGATTGTGAC TAGCGTAGCA TCGCTTCTAG ACATATACTA TATAGTAATA	6240
35	CCAATACTCA AGACTACGAA ACTGATACAA TCTCTTATCA TGTGGGTAAT GTTCTGATG	6300
	TOGAATAGCC ATATGCGGT AGTTCGATA TACATAAAT GATCACTAAT TCCAAACCCA	6360
	CCGCTTTTT ATAGTAAGTT TTTCACCCAT AAATAATAAA TACAATAATT AATTTCTGTT	6420
40	AAAGTAGAA AATATATTCT AATTTATTGC ACGGTAAGGA AGTAGAATCA TAAAGAACAG	6480
	TGAOGATCC OGGGATGGCC ACACAGGGAC AACGGTCAA CTGGGGAGAT GAACCTTCCA	6540
	AAAGACGTGG TGTTCCTAAC TCTGTGGTC GGAAGAATAA TGATATACCT TTGTCTTCT	6600
	ACAACCCCAT TACCTCGAA CAAGGATCTA AATTTGGAA TTTATGTCCG AGAGACCTTG	6660
45	TTCCCAAAGG AATAGGTAAT AAGGATCAAC AATTTGGTTA TTGGAATAGA CAGATTGTT	6720
	ATGTTATTGT AAAAGGCCAG CGTAAGGAAC TCGCTGAGAG GTGGTTCTTT TACTTCTTAG	6780

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GTACAGGACC TCATGCTGAT GCTAAATTCA AAGACAAGAT TGATGGAGTC TTCTGGGTTG	6840
CAAGGGATGG TGCCATGAAC AAGCCACAAA CGCTTGGCAC TGGTGGAAAC AATAACGAAT	6900
CCAAACCACT GAGATTTGAT GGTAAAGATAC CGCCACAGTT TCAGCTTGAA GTGAACCGTT	6960
CTAGGAACAA TTCAAGGTCT GGTTCCTCAGT CTAGATCTGT TTCAAGAAAC AGATCTCAAT	7020
CTAGAGGAAG ACACCATTC CATAACCAGA ATAATAATGT TGAGGATACA ATTGTAGCCG	7080
TGCTTGAAAA ATTAGGTGTT ACTGACAAAC AAAGGTCAAG TTCTAAACCT AGAGAACGTA	7140
GTGATTCCAA ACCTAGGGAC ACAACACCTA AGAATGCCAA CAAACACACC TGGAAAGAAA	7200
CTGCAGGCAA GGGAGATGTG ACAACTTTCT ATGGTCTAG AAGTAGTTCA GCTAACTTTG	7260
GTGATAGTGA TCTCGTTGCC AATGGTAAAG CTGCCAAATG CTACCCCTAG ATAGCTGAAT	7320
GTGTTCCATC AGTGTCTAGC ATAATCTTTG GCAGTCAATG GTCTGCTGAA GAAGCTGGTG	7380
ATCAAGTGAA AGTCAAGCTC ACTCACACCT ACTACCTGCC AAAGGATGAT GCCAAACTA	7440
GTCAATTCCCT AGAACAGATT GACGCTTACA AGCGACCTTC TGAAGTGGCT AAGGATCAGA	7500
GGCAAAGAAG ATCCCGTTCT AAGTCTGCTG ATAAGAAGCC TGAGGAGTTG TCTGTAAGTC	7560
TTGTGGAGGC ATACACAGAT GTGTTTGATG ACACACAGGT TGAGATGATT GATGAGGTTA	7620
CGAACTAAAC GCATGCCCGG GAATTCCTGT AGCGTATGCC AAACGAAGGA AAAATTAGTT	7680
ATAGTAGCCG CACTCGATGG GACATTTCAA CGTAAACCGT TTAATAATAT TTTGAATCTT	7740
ATTCCATTAT CTGAAATGGT GGTAAGACTA ACTGCTGTGT GTATGAAATG CTTTAAGGAG	7800
GCTTCCTTTT CTAAAGGATT GGGTGAGGAA ACCGAGATAG AAATAATAGG AGGTAATGAT	7860
ATGTATCAAT CGGTGTGTAG AAGTGTGTAC ATCGACTCAT AATATTATAT TTTTATCTA	7920
AAAACTAAA AATAACATT GATTAAATTT TAATATAATA CTTAAAAATG GATGTTGTGT	7980
CGTTAGATAA ACGTTTATG TATTTTGAGG AABTTGATAA TGAGTTAGAT TACGAACGAG	8040
AAAGTGCAA TGAGGTGCA AAAAACTGC CGTATCAAGG ACAGTTAAAA CTATTACTAG	8100
GAGAAATTAT TTTTCTTAGT AAGTTACAGC GACACGGTAT ATTAGATGGT GCCACCGTAG	8160
TGTATATAGG ATCTGCTCCC GGTACACATA TACGTTATTT GAGAGATCAT TTCTATAATT	8220
TAGGAGTGAT CATCAATGG ATGCTAATG ACGGCGCCA TCATGATCCT ATTTTAAATG	8280
GATTGCGTGA TGTGACTCTA GTGACTGGT TCGTTGATGA GGAATATCTA CGATCCATCA	8340
AAAACAACCT GCATCCTTCT AAGATTATTT TAATTTCTGA TGTGAGATCC AAACGAGGAG	8400

	GAAATGAACC TAGTAAGGCG GATTTACTAA GTAATTACGC TCTACAAAAT GTCATGATTA	8460
5	GTATTTTAAA CCOGTGGCG TCTAGTCCTA AATGGAGATG CCOGTTTCCA GATCAATGGA	8520
	TCAAGGACTT TTATATOCCA CAOGGTATA AAATGTTACA ACCTTTTGCT CCTTCATAAT	8580
	CAGGGCOGTC GTTTTACAAC GTGGTACTG GGAAAACCTT GGCGTTACCC AACTTAATCG	8640
10	CCTTGACGCA CATCCCCCTT TCGCCAGCTG GCGTAATAGC GAAGAGGCCG GCACOGATOG	8700
	CCCTTCCCAA CAGTTGCGCA GCCTGAATGG CGAATGGGCG CTGATGCGGT ATTTTCTCTT	8760
	TACGCATCTG TGCGGTATTT CACACCGCAT ATGGTGCACT CTCAGTACCA TCTGCTCTGA	8820
15	TGCGCATAG TTAAGCCAGT AACTTCOGCT ATCGCTACGT GACTGGGTCA TGGCTGCGCC	8880
	CGACACCOG CCAACACCOG CTGAOGGCG CTGACGGGCT TGTCTGCTCC OGGCATCOGC	8940
	TTACAGACAA GCTGTGACCG TCTCOGGGAG CTGCATGCT CAGAGGTTT CACCGTCATC	9000
20	ACGAAACGC GCGAGGCAG	9019

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Claims

1. A recombinant raccoon poxvirus having at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of Feline Infectious Peritonitis Virus (FIPV).
2. The recombinant raccoon poxvirus of claim 1 wherein said internal gene encodes the N protein of FIPV having the amino acid sequence as set out in Figure 1B.
3. The recombinant raccoon poxvirus of claim 1 wherein said internal gene encodes the M/E1 protein of FIPV having the amino acid sequence as set out in Figure 1A.
4. The recombinant raccoon poxvirus of claim 1 wherein said virus has genes encoding the E1 and N proteins of FIPV.
5. A vaccine comprising:
 - a recombinant raccoon poxvirus having at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of Feline Infectious Peritonitis Virus (FIPV),
 - a pharmaceutically acceptable carrier or diluent, and
 - a pharmaceutically acceptable adjuvant.
6. The vaccine of claim 5 wherein said internal gene encodes the N protein of FIPV having the amino acid sequence as set out in Figure 1B.
7. The vaccine of claim 5 wherein said internal gene encodes the M/E1 protein of FIPV having the amino acid sequence as set out in Figure 1A.
8. The vaccine of claim 5 wherein said virus has genes encoding the E1 and N proteins of FIPV.
9. The vaccine of claim 5 further comprising inactivated or attenuated viruses selected from the group consisting of feline leukemia virus, feline panleucopenia virus, feline rhinotracheitis virus, feline calicivirus, feline immunodeficiency virus, feline herpesvirus, feline enteric coronavirus, or mixtures thereof.

10. The vaccine of claim 5 further comprising inactivated or attenuated feline *Chlamydia psittaci*, *Microsporium canis*, or mixtures thereof.
11. A vaccine comprising:
 - 5 a first recombinant raccoon poxvirus having at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of Feline Infectious Peritonitis Virus (FIPV),
 - a second recombinant raccoon poxvirus having at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of Feline Infectious Peritonitis Virus (FIPV),
 - 10 a pharmaceutically acceptable carrier or diluent, and
 - a pharmaceutically acceptable adjuvant.
12. A method for preventing disease caused by Feline Infectious Peritonitis Virus (FIPV), comprising administering to a feline in need of such treatment a vaccine comprising a recombinant raccoon poxvirus having at least one internal gene comprising a DNA sequence encoding a member selected from the group consisting of the nucleocapsid (N) and transmembrane (M/E1) proteins of FIPV.
13. The method of claim 12 wherein said internal gene encodes the N protein of FIPV having the amino acid sequence as set out in Figure 1B.
14. The method of claim 12 wherein said internal gene encodes the M/E1 protein of FIPV having the amino acid sequence as set out in Figure 1A.
15. The method of claim 12 wherein said virus has genes encoding the E1 and N proteins of FIPV.

Sequence Range: 1 to 789

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      10      20      30      40
      *      *      *      *
ATG AAG TAC ATT TTG CTA ATA CTC GCG TGC ATA ATT GCA TGC GTT TAT
TAC TTC ATG TAA AAC GAT TAT GAG CGC ACG TAT TAA CGT ACG CAA ATA
M K Y I L L I L A C I I A C V Y>
a a a a TRANSLATION OF FIPV El a a a a a >

50      60      70      80      90
*      *      *      *      *
GGT GAA CGC TAC TGT GCC ATG CAA GAC AGT GGC TTG CAG TGT ATT AAT
CCA CTT GCG ATG ACA CGG TAC GTT CTG TCA CCG AAC GTC ACA TAA TTA
G E R Y C A M Q D S G L Q C I N>
a a a a TRANSLATION OF FIPV El a a a a a >

100     110     120     130     140
*      *      *      *      *
GGC ACA AAT TCA AGA TGT CAA ACC TGC TTT GAA CGT GGT GAT CTT ATT
CCG TGT TTA AGT TCT ACA GTT TGG ACG AAA CTT GCA CCA CTA GAA TAA
G T N S R C Q T C F E R G D L I>
a a a a TRANSLATION OF FIPV El a a a a a >

150     160     170     180     190
*      *      *      *      *
TGG CAT CTT GCT AAC TGG AAC TTC AGC TGG TCT GTA ATA TTG ATT GTT
ACC GTA GAA CGA TTG ACC TTG AAG TCG ACC AGA CAT TAT AAC TAA CAA
W H L A N W N F S W S V I L I V>
a a a a TRANSLATION OF FIPV El a a a a a >

200     210     220     230     240
*      *      *      *      *
TTT ATA ACA GTG TTA CAA TAT GGC AGA CCA CAA TTT AGC TGG CTC GTT
AAA TAT TGT CAC AAT GTT ATA CCG TCT GGT GTT AAA TCG ACC GAG CAA
F I T V L Q Y G R P Q F S W L V>
a a a a TRANSLATION OF FIPV El a a a a a >

250     260     270     280
*      *      *      *
TAT GGC ATT AAA ATG CTG ATC ATG TGG CTA TTA TGG CCT ATT GTT CTA
ATA CCG TAA TTT TAC GAC TAG TAC ACC GAT AAT ACC GGA TAA CAA GAT
Y G I K M L I M W L L W P I V L>
a a a a TRANSLATION OF FIPV El a a a a a >

290     300     310     320     330
*      *      *      *      *
GCG CTT ACG ATT TTT AAT GCA TAC TCT GAG TAC CAA GTT TCC AGA TAT
CGC GAA TGC TAA AAA TTA CGT ATG AGA CTC ATG GTT CAA AGG TCT ATA
A L T I F N A Y S E Y Q V S R Y>
a a a a TRANSLATION OF FIPV El a a a a a >

340     350     360     370     380
*      *      *      *      *
GTA ATG TTC GGC TTT AGT GTT GCA GGT GCA GTT GTA ACG TTT GCA CTT
CAT TAC AAG CCG AAA TCA CAA CGT CCA CGT CAA CAT TGC AAA CGT GAA
V M F G F S V A G A V V T F A L>
a a a a TRANSLATION OF FIPV El a a a a a >

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FIG. 1A-1

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      390          400          410          420          430
      *           *           *           *           *
TGG ATG ATG TAT TTT GTG AGA TCT GTT CAG CTA TAT AGA AGA ACC AAA
ACC TAC TAC ATA AAA CAC TCT AGA CAA GTC GAT ATA TCT TCT TGG TTT
W  M  M  Y  F  V  R  S  V  Q  L  Y  R  R  T  K>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      440          450          460          470          480
      *           *           *           *           *
TCA TGG TGG TCT TTT AAT CCT GAG ACT AAT GCA ATT CTT TGT GTT AAT
AGT ACC ACC AGA AAA TTA GGA CTC TGA TTA CGT TAA GAA ACA CAA TTA
S  W  W  S  F  N  P  E  T  N  A  I  L  C  V  N>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      490          500          510          520
      *           *           *           *
GCA TTG GGT AGA AGT TAT GTG CTT CCC TTA GAT GGT ACT CCT ACA GGT
CGT AAC CCA TCT TCA ATA CAC GAA GGG AAT CTA CCA TGA GGA TGT CCA
A  L  G  R  S  Y  V  L  P  L  D  G  T  P  T  G>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

530          540          550          560          570
*           *           *           *           *
GTT ACC CTT ACT CTA CTT TCA GGA AAT CTA TAT GCT GAA GGT TTC AAA
CAA TGG GAA TGA GAT GAA AGT CCT TTA GAT ATA CGA CTT CCA AAG TTT
V  T  L  T  L  L  S  G  N  L  Y  A  E  G  F  K>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      580          590          600          610          620
      *           *           *           *           *
ATG GCT GGT GGT TTA ACC ATC GAG CAT TTG CCT AAA TAC GTC ATG ATT
TAC CGA CCA CCA AAT TGG TAG CTC GTA AAC GGA TTT ATG CAG TAC TAA
M  A  G  G  L  T  I  E  H  L  P  K  Y  V  M  I>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      630          640          650          660          670
      *           *           *           *           *
GCT ACA CCT AGT AGA ACC ATC GTT TAT ACA TTA GTT GGA AAA CAA TTA
CGA TGT GGA TCA TCT TGG TAG CAA ATA TGT AAT CAA CCT TTT GTT AAT
A  T  P  S  R  T  I  V  Y  T  L  V  G  K  Q  L>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      680          690          700          710          720
      *           *           *           *           *
AAA GCA ACT ACT GGC ACA GGA TGG GCT TAC TAC GTA AAA TCT AAA GCT
TTT CGT TGA TGA CGG TGT CCT ACC CGA ATG ATG CAT TTT AGA TTT CGA
K  A  T  T  A  T  G  W  A  Y  Y  V  K  S  K  A>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

      730          740          750          760
      *           *           *           *
GGT GAT TAC TCA ACA GAA GCA CGT ACT GAC AAT TTG AGT GAA CAT GAA
CCA CTA ATG AGT TGT CTT CGT GCA TGA CTG TTA AAC TCA CTT GTA CTT
G  D  Y  S  T  E  A  R  T  D  N  L  S  E  H  E>
a  a  a  a  TRANSLATION OF FIPV El a  a  a  a  a  >

770          780
*           *
AAA TTA TTA CAT ATG GTG TAA
TTT AAT AAT GTA TAC CAC ATT
K  L  L  H  M  V  *>
TRANSLATION OF FIPV >

```

FIG. 1A-2

Sequence Range: 1 to 1134

```

      10      20      30      40
      *      *      *      *
ATG GCC ACA CAG GGA CAA CGC GTC AAC TGG GGA GAT GAA CCT TCC AAA
TAC CGG TGT GTC CCT GTT GCG CAG TTG ACC CCT CTA CTT GGA AGG TTT
M  A  T  Q  G  Q  R  V  N  W  G  D  E  P  S  K>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

50      60      70      80      90
*      *      *      *      *
AGA CGT GGT CGT TCT AAC TCT CGT GGT CGG AAG AAT AAT GAT ATA OCT
TCT GCA CCA GCA AGA TTG AGA GCA CCA GCC TTC TTA TTA CTA TAT GGA
R  R  G  R  S  N  S  R  G  R  K  N  N  D  I  P>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

100     110     120     130     140
*      *      *      *      *
TTG TCA TTC TAC AAC CCC ATT ACC CTC GAA CAA GGA TCT AAA TTT TGG
AAC AGT AAG ATG TTG GGG TAA TGG GAG CTT GTT CCT AGA TTT AAA ACC
L  S  F  Y  N  P  I  T  L  E  Q  G  S  K  F  W>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

150     160     170     180     190
*      *      *      *      *
AAT TTA TGT CCG AGA GAC CTT GTT CCC AAA GGA ATA GGT AAT AAG GAT
TTA AAT ACA GGC TCT CTG GAA CAA GGG TTT CCT TAT CCA TTA TTC CTA
N  L  C  P  R  D  L  V  P  K  G  I  G  N  K  D>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

200     210     220     230     240
*      *      *      *      *
CAA CAA ATT GGT TAT TGG AAT AGA CAG ATT CGT TAT CGT ATT GTA AAA
GTT GTT TAA CCA ATA ACC TTA TCT GTC TAA GCA ATA GCA TAA CAT TTT
Q  Q  I  G  Y  W  N  R  Q  I  R  Y  R  I  V  K>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

250     260     270     280
*      *      *      *
GGC CAG CGT AAG GAA CTC GCT GAG AGG TGG TTC TTT TAC TTC TTA GGT
CCG GTC GCA TTC CTT GAG CGA CTC TCC ACC AAG AAA ATG AAG AAT CCA
G  Q  R  K  E  L  A  E  R  W  F  F  Y  F  L  G>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

290     300     310     320     330
*      *      *      *      *
ACA GGA OCT CAT GCT GAT GCT AAA TTC AAA GAC AAG ATT GAT GGA GTC
TGT CCT GGA GTA CGA CTA CGA TTT AAG TTT CTG TTC TAA CTA CCT CAG
T  G  P  H  A  D  A  K  F  K  D  K  I  D  G  V>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

340     350     360     370     380
*      *      *      *      *
TTC TGG GTT GCA AGG GAT GGT GCC ATG AAC AAG CCC ACA ACG CTT GGC
AAG ACC CAA CGT TCC CTA CCA CGG TAC TTG TTC GGG TGT TGC GAA CCG
F  W  V  A  R  D  G  A  M  N  K  P  T  T  L  G>
a  a  a  a  TRANSLATION OF FIPV N a a a a a >

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FIG. 1B-1

```

      390          400          410          420          430
      *          *          *          *          *
ACT CGT GGA ACC AAT AAC GAA TCC AAA CCA CTG AGA TTT GAT GGT AAG
TGA GCA CCT TGG TTA TTG CTT AGG TTT GGT GAC TCT AAA CTA CCA TTC

T  R  G  T  N  N  E  S  K  P  L  R  F  D  G  K>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      440          450          460          470          480
      *          *          *          *          *
ATA CCG CCA CAG TTT CAG CTT GAA GTG AAC CGT TCT AGG AAC AAT TCA
TAT GGC GGT GTC AAA GTC GAA CTT CAC TTG GCA AGA TCC TTG TTA AGT
I  P  P  Q  F  Q  L  E  V  N  R  S  R  N  N  S>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      490          500          510          520
      *          *          *          *
AGG TCT GGT TCT CAG TCT AGA TCT GTT TCA AGA AAC AGA TCT CAA TCT
TCC AGA CCA AGA GTC AGA TCT AGA CAA AGT TCT TTG TCT AGA GTT AGA
R  S  G  S  Q  S  R  S  V  S  R  N  R  S  Q  S>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

530          540          550          560          570
*          *          *          *          *
AGA GGA AGA CAC CAT TCC AAT AAC CAG AAT AAT AAT GTT GAG GAT ACA
TCT OCT TCT GTG GTA AGG TTA TTG GTC TTA TTA TTA CAA CTC CTA TGT
R  G  R  H  H  S  N  N  Q  N  N  N  V  E  D  T>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      580          590          600          610          620
      *          *          *          *          *
ATT GTA GGC GTG CTT GAA AAA TTA GGT GTT ACT GAC AAA CAA AGG TCA
TAA CAT CGG CAC GAA CTT TTT AAT CCA CAA TGA CTG TTT GTT TCC AGT
I  V  A  V  L  E  K  L  G  V  T  D  K  Q  R  S>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      630          640          650          660          670
      *          *          *          *          *
CGT TCT AAA CCT AGA GAA CGT AGT GAT TCC AAA CCT AGG GAC ACA ACA
GCA AGA TTT GGA TCT CTT GCA TCA CTA AGG TTT GGA TCC CTG TGT TGT
R  S  K  P  R  E  R  S  D  S  K  P  R  D  T  T>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      680          690          700          710          720
      *          *          *          *          *
CCT AAG AAT GCC AAC AAA CAC ACC TGG AAG AAA ACT GCA GGC AAG GGA
GGA TTC TTA CGG TTG TTT GTG TGG ACC TTC TTT TGA CGT CCG TTC CCT
P  K  N  A  N  K  H  T  W  K  K  T  A  G  K  G>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

      730          740          750          760
      *          *          *          *
GAT GTG ACA ACT TTC TAT GGT GCT AGA AGT AGT TCA GCT AAC TTT GGT
CTA CAC TGT TGA AAG ATA CCA CGA TCT TCA TCA AGT CGA TTG AAA CCA
D  V  T  T  F  Y  G  A  R  S  S  S  A  N  F  G>
a  a  a  a  TRANSLATION OF FIPV N a  a  a  a  a  >

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FIG. 1B-2

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770          780          790          800          810
*           *           *           *           *
GAT AGT GAT CTC GTT GCC AAT GGT AAC GCT GCC AAA TGC TAC CCT CAG
CTA TCA CTA GAG CAA CGG TTA CCA TTG CGA CGG TTT ACG ATG GGA GTC
D S D L V A N G N A A K C Y P Q>
a a a a TRANSLATION OF FIPV N a a a a a >

820          830          840          850          860
*           *           *           *           *
ATA GCT GAA TGT GTT CCA TCA GTG TCT AGC ATA ATC TTT GGC AGT CAA
TAT CGA CTT ACA CAA GGT AGT CAC AGA TCG TAT TAG AAA CCG TCA GTT
I A E C V P S V S S I I F G S Q>
a a a a TRANSLATION OF FIPV N a a a a a >

870          880          890          900          910
*           *           *           *           *
TGG TCT GCT GAA GAA GCT GGT GAT CAA GTG AAA GTC ACG CTC ACT CAC
ACC AGA CGA CTT CTT CGA CCA CTA GTT CAC TTT CAG TGC GAG TGA GTG
W S A E E A G D Q V K V T L T H>
a a a a TRANSLATION OF FIPV N a a a a a >

920          930          940          950          960
*           *           *           *           *
ACC TAC TAC CTG CCA AAG GAT GAT GCC AAA ACT AGT CAA TTC CTA GAA
TGG ATG ATG GAC GGT TTC CTA CTA CGG TTT TGA TCA GTT AAG GAT CTT
T Y Y L P K D D A K T S Q F L E>
a a a a TRANSLATION OF FIPV N a a a a a >

970          980          990          1000
*           *           *           *
CAG ATT GAC GCT TAC AAG CGA CCT TCT GAA GTG GCT AAG GAT CAG AGG
GTC TAA CTG CGA ATG TTC GCT GGA AGA CTT CAC CGA TTC CTA GTC TCC
Q I D A Y K R P S E V A K D Q R>
a a a a TRANSLATION OF FIPV N a a a a a >

1010          1020          1030          1040          1050
*           *           *           *           *
CAA AGA AGA TCC CGT TCT AAG TCT GCT GAT AAG AAG CCT GAG GAG TTG
GTT TCT TCT AGG GCA AGA TTC AGA CGA CTA TTC TTC GGA CTC CTC AAC
Q R R S R S K S A D K K P E E L>
a a a a TRANSLATION OF FIPV N a a a a a >

1060          1070          1080          1090          1100
*           *           *           *           *
TCT GTA ACT CTT GTG GAG GCA TAC ACA GAT GTG TTT GAT GAC ACA CAG
AGA CAT TGA GAA CAC CTC CGT ATG TGT CTA CAC AAA CTA CTG TGT GTC
S V T L V E A Y T D V F D D T Q>
a a a a TRANSLATION OF FIPV N a a a a a >

1110          1120          1130
*           *           *
GTT GAG ATG ATT GAT GAG GTT ACG AAC TAA
CAA CTC TAC TAA CTA CTC CAA TGC TTG ATT
V E M I D E V T N *>
a TRANSLATION OF FIPV N a a >

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FIG. 1B-3

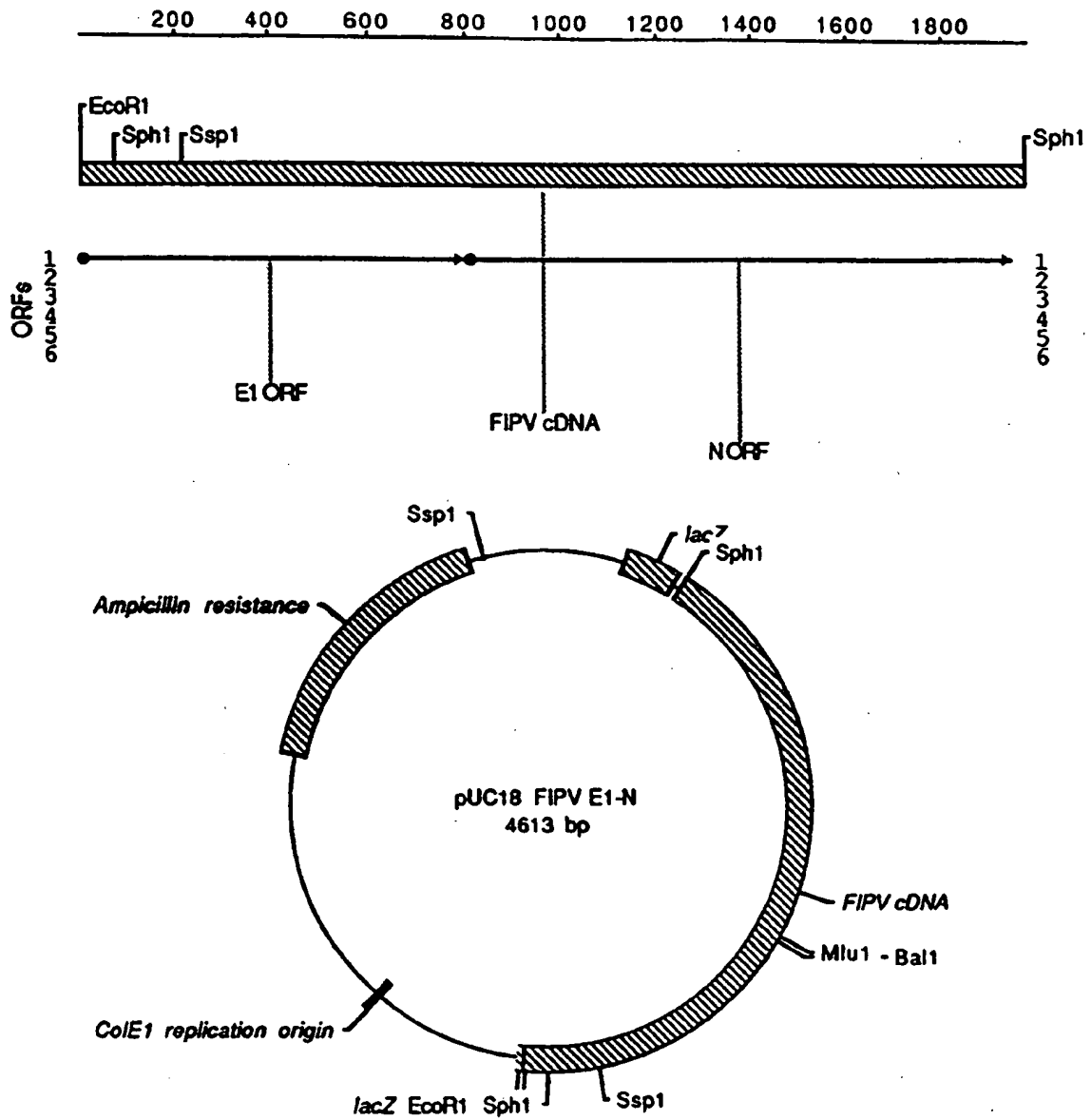


FIG. 2

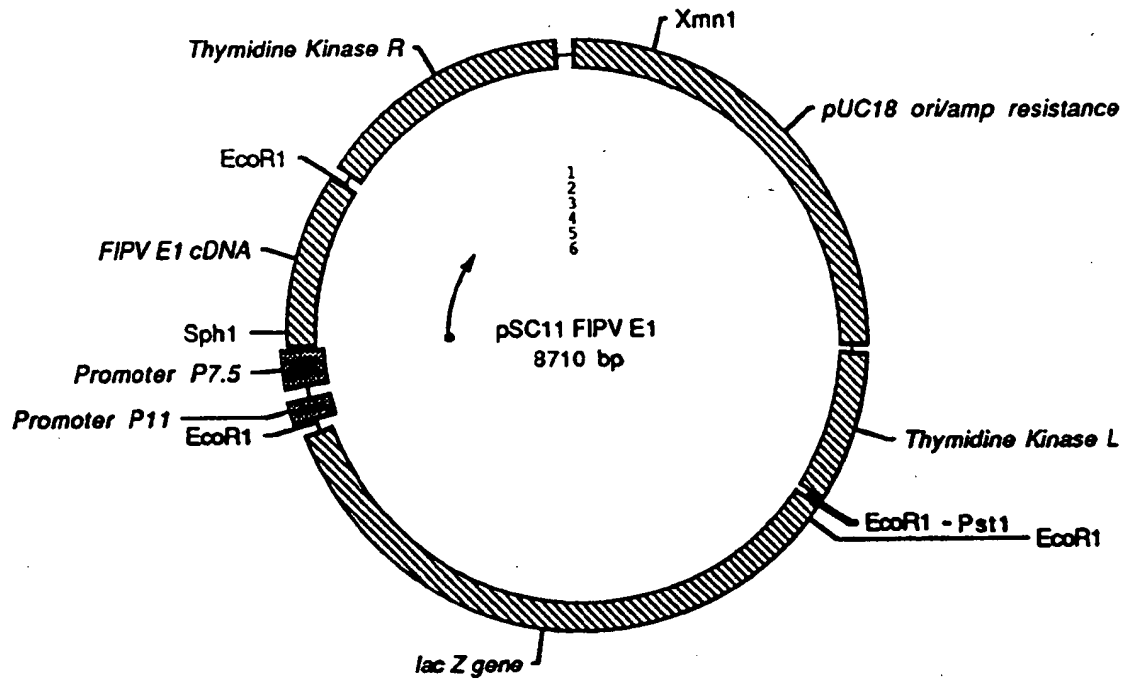


FIG. 3B

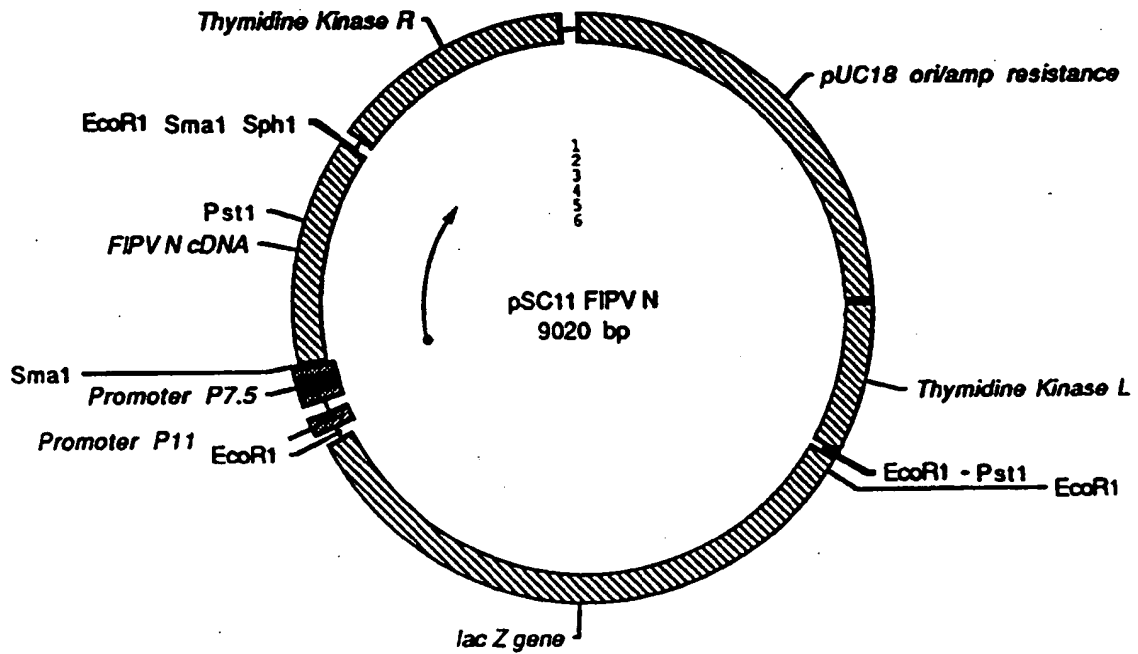


FIG. 3C

FEATURES	From	To/Span	Description
DNA	1	2233	pUC18 ori/amp resistance
DNA	7377	8637	Thymidine Kinase R
DNA	6080	3030 (C)	lac Z gene
DNA	2240	3000	Thymidine Kinase L
signal	6250	6130 (C)	Promoter P11
signal	6300	6480	Promoter P7.5
DNA	6493	7329	FIPV E1 cDNA
ORF	6525	7313	1 E1 ORF
1	CGAAAGGGCC	TCGTGATACG	CCTATTTTTA TAGGTTAATG TCATGATAAT AATGGTTTCT
61	TAGACGTCAG	GTGSCACTTT	TCGGGGAAAT GTGCGCGGAA CCCCTATTG TTTATTTTTC
121	TAAATACATT	CAAAATATGTA	TCCGCTCATG AGACAATAAC CCTGATAAAT GCTTCAATAA
181	TATTGAAAAA	GGAAGAGTAT	GAGTATTCAA CATTTCCGTG TCGCCCTTAT TCCCTTTTTT
241	GCGGCATTTT	GCCTTCCTGT	TTTTGCTCAC CCAGAAACGC TGGTGAAAGT AAAAGATGCT
301	GAAGATCAGT	TGGGTGCACG	AGTGGGTTAC ATCGAACTGG ATCTCAACAG CGGTAAGATC
361	CTTGAGAGTT	TTCGCCCCGA	AGAACGTTTT CCAATGATGA GCACTTTTAA AGTTCGTCTA
421	TGTGGCGCGG	TATTATCCCG	TATTGACGCC GGGCAAGAGC AACTCGGTG CCGCATACAC
481	TATTCTCAGA	ATGACTTGGT	TGAGTACTCA CCAGTCACAG AAAAGCATCT TACGGATGGC
541	ATGACAGTAA	GAGAATTATG	CAGTGCTGCC ATAACCATGA GTGATAACAC TCGGGCCAAAC
601	TTACTTCTGA	CAACGATCGG	AGGACCGAAG GAGCTAACCG CTTTTTTGCA CAACATGGGG
661	GATCATGTAA	CTCGCCTTGA	TCGTTGGGAA CCGGAGCTGA ATGAAGCCAT ACCAAACGCA
721	GAGCGTGACA	CCACGATGCC	TGTAGCAATG GCAACAACTG TCGCCAAACCT ATTAAGTGGC
781	GAACTACTTA	CTCTAGCTTC	CCGGCAACAA TTAATAGACT GGATGGAGGC GGATAAAGTT
841	GCAGGACCAC	TTCTGCGCTC	GGCCCTTCCG GCTGGCTGGT TTATTCCTGA TAAATCTGGA
901	GCGGTGAGC	GTGGGTCTCG	CGGTATCATT GCAGCACTGG GGCCAGATGG TAAGCCCTCC
961	CGTATCGTAG	TTATCTACAC	GACGGGGAGT CAGGCAACTA TGGATGAACG AAATAGACAG
1021	ATCGCTGAGA	TAGGTGCCTC	ACTGATTAACT CATTGGTAAAC TGTACAGCCA AGTTTACTCA
1081	TATATACTTT	AGATTGATTT	AAAACCTTCAT TTTTAATTTA AAAGGATCTA GGTGAAGATC
1141	CTTTTTGATA	ATCTCATGAC	CAAAATCCCT TAAOGTGAGT TTTGCTTCCA CTGAGCGTCA
1201	GACCCCGTAG	AAAAGATCAA	AGGATCTTCT TGAGATCCTT TTTTCTGCG CGTAATCTGC
1261	TGCTTGCAAA	CAAAAAAACC	ACCGCTACCA GCGGTGGTTT GTTTGCGGGA TCAAGAGCTA
1321	CCAACTCTTT	TTCGAAAGGT	AACTGGCTTC AGCAGAGGCG AGATAACCAA TACTGTCTTT
1381	CTAGTGTAGC	CGTAGTTAGG	CCACCACTCT AAGAACTCTG TAGCAACGCG TACATACCTC
1441	GCTCTGCTAA	TCTGTATACC	AGTGGCTGCT GOCAGTGGCG ATTAAGTCGTG TCTTACCGGG
1501	TTGGACTCAA	GACGATAGTT	ACCGGATAAG GCGCAGGGT CCGGCTGAAC GGGGGGTTG
1561	TGCACACAGC	CCAGCTTGGA	GCGAACGAAC TACACCGAAC TGAGATAOCT ACAGCGTGAG
1621	CATTGAGAAA	GCGCCACGCT	TCCCGAAGGG AGAAAGGCGG ACAGGTATCC GGTAAGCGGC
1681	AGGGTOGGAA	CAGGAGAGCG	CACGAGGGAG CTTCAGGGG GAAACGCTG GTATCTTTAT
1741	AGTCCTGTG	GGTTTGCCCA	CCTCTGACTT GAGCGTCGAT TTTTGTGATG CTCGTTCAGGG
1801	GGGCGGAGCC	TATGGAAAAA	CGCCAGCAAC GCGGCCTTTT TACGGTTCTT GGCCTTTTGC
1861	TGGCCTTTTG	CTCACATGTT	CTTCTCTGCG TTATCCCTG ATCTGTGGA TAACCGTATT
1921	ACCGCCTTTG	AGTGAGCTGA	TACCGCTGCG CGCAGCCGAA CGACCGAGCG CAGCGAGTCA
1981	GTGAGOGAGG	AAGCGGAAGA	GCGCCCAATA CGCAAACGCG CTCTCCCCGC GCGTTGGCG
2041	ATTCATTAAAT	GCAGCTGGCA	CGACAGTTT CCGGACTGGA AAGCGGCGAG TGAGCGCAAC
2101	GCAATTAATG	TGAGTTAGCT	CACTCATTAG GCACCCAGG CTTTACACTT TATGCTTCCG
2161	GCTCGTATGT	TGTGTGGAAT	TGTGAGCGGA TAACAATTTT ACACAGGAAA CAGCTATGAC
2221	CATGATTACG	CCAAGCTTTT	GCGATCAATA AATGGATCAC AACCAGTATC TCTTAACGAT
2281	GTTCTTCGCA	GATGATGATT	CATTTTTTAA GTATTTGGCT AGTCAAGATG ATGAAATCTT
2341	CATTATCTGA	TATATTGCAA	ATCACTCAAT ATCTAGACTT TCTGTTATTA TTATTGATCC
2401	AATCAAAAAA	TAAATTAGAA	GCCGTGGGTC ATTGTTATGA ATCTCTTTCA GAGGAATACA
2461	GACAATTGAC	AAAATTACAA	GACTTTCAAG ATTTTAAAAA ACTGTTTAAAC AAGGTCCCTA
2521	TTGTTACAGA	TGGAAGGGTC	AAACTTAATA AAGGATATTT GTTCGACTTT GTGATTAGTT
2581	TGATGCGATT	CAAAAAAGAA	TCCTCTCTAG CTACCACCGC AATAGATCCT GTTAGATACA
2641	TAGATCTCTG	TCCCAATATC	GCATTTTCTA ACGTGATGGA TATATTAAAG TCGAATAAAG
2701	TGAACAATAA	TTAATTCTTT	ATTGTCAATCA TGAACGGCGG ACATATTTCAG TTGATAATCG
2761	GCCCCATGTT	TTCAGGTAAA	AGTACAGAAT TAATTAGACG AGTTAGACGT TATCAAATAG
2821	CTCAATATAA	ATCGTGACT	ATAAAATATT CTAACGATAA TAGATACCGA ACGGGACTAT
2881	GGACGCATGA	TAAGAATAAT	TTTGAAGCAT TGAAGCAAC TAAACTATGT GATCTCTTGG
2941	AATCAATTAC	AGATTTCTCC	GTGATAGGTA TCGATGAAGG ACAGTTCTTT CCAGACATTG
3001	TTGAATTCCG	AGCTTGGCTG	CAGGTCGGGG ATCCCCCTG CCCGGTTATT ATTATTTTTG
3061	ACACGAGACC	AACCTGTAAT	GGTAGCGAAC GCGGCTCAGC TGAATTTCCG CGATACTGAC
3121	GGGCTCCAGG	AGTCGTGCGC	ACCAATCCCC ATATGGAAC CGTCGATATT CAGCCATGTG

FIG. 4A-1

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3181 CCTTCTTCCG CGTGCAGCAG ATGGCGATGG CTGGTTTCCA TCAGTTGCTG TTGACTGTAG
3241 CGGCTGATGT TGAAGTGGAA GTCGCCGCGC CACTGGTGTG GGCCATAATT CAATTCCGCG
3301 GTCCCGCAGC GCAGACCGTT TTCGCTCGGG AAGACGTACG GGGTATACAT GTCTGACAA
3361 GGCAGATCCC AGCGGTCAAA ACAGGCGGCA GTAAGGCGGT CGGGATAGTT TTCTTGCGGC
3421 CCTAATCCGA GCCAGTTTAC CCGCTCTGCT ACCTGCGCCA GCTGGCAGTT CAGGCCAATC
3481 CGCGCCGGAT GCGGTGTATC GCTCGCCACT TCAACATCAA CGGTATTCGC CATTGTGACCA
3541 CTACCATCAA TCCGGTAGGT TTTCCGGCTG ATAAATAAGG TTTTCCCTG ATGCTGCCAC
3601 GCGTGACCGG TCGTAATCAG CACCGCATCA GCAAGTGTAT CTGCCGTGCA CTGCAACAAC
3661 GCTGCTTCGG CCTGGTAATG GCCCGCCGCC TTCCAGCGTT CGACCCAGGC GTTAGGGTCA
3721 ATGCGGGTGC CTTCACTTAC GCCAATGTCG TTATCCAGCG GTGCACGGGT GAACTGATCG
3781 CGCAGCGGCG TCAGCAGTTG TTTTATATCG CCAATCCACA TCTGTGAAAG AAAGCCTGAC
3841 TGGCGGTAA ATTGCCAACG CTTATTACCC AGCTCGATGC AAAAAATCCAT TTCGCTGGTG
3901 GTCAGATGCG GGATGGCGTG GGACGCGGCG GGGAGCGTCA CACTGAGGTT TTCGCCAGA
3961 GCCACATGCT GCCAGGCGCT GATGTGCCCG GCTTCTGACC ATGCGGTGCG GTTCGGTTGC
4021 ACTACGCGTA CTGTGAGCCA GAGTTGCCCG GCGCTCTCCG GCTGCGGTAG TTCAGGTCAGT
4081 TCAATCAACT GTTACCTTG TGGAGCGACA TOCAGAGGCA CTTACCGCT TGCCAGCGGC
4141 TTACCATCCA GCGCCACCAT CCAGTGCAGG AGCTCGTTAT CGCTATGACG GAACAGGTAT
4201 TCGCTGGTCA CTTGATGGT TTGCCCGGAT AAACGGAACT GGAAAACTG CTGCTGGTGT
4261 TTTGCTTCGG TCAGCGCTGG ATGCGGCGTG CCGTCCGCAA AGACAGACC GTTCATACAG
4321 AACTGGCGAT CGTTCGGCGT ATCGCCAAAA TCACCGCGT AAGCCGACCA CGGGTTGCCG
4381 TTTTTCATCAT ATTTAATCAG CGACTGATCC ACCCAGTCCC AGACGAAAGC GCOCTGTAAA
4441 CGGGGATACT GACGAAACGC CTGCCAGTAT TTAGCGAAAC CGOCAAGACT GTTACCATC
4501 GCGTGGGCGT ATTGCAAAAG GATCAGCGGG CGGCTCTCTC CAGGTAGCGA AAGCCATTTT
4561 TTGATGGACC ATTTCGGCAC AGCCCGGAAG GGCTGGTCTT CATCCACGCG CGCGTACATC
4621 GGGCAATAA TATCGGTGGC CGTGGTGTGC GCTCCGCGCG CTTTACTACTG CACCGGGGCG
4681 GAAGGATCGA CAGTTTGAT CCAGCGATAC AGCGCGTGTG GATTAGCGCG GTGGCCTGAT
4741 TCAATCCCCA GCGACCATGAT GATCAGACTC GGGTGATFAC GATCGCGCTG CATCCATGCG
4801 GTTACGCGTT CGCTCATGCG CGGTAGCCAG CGCGGATCAT CGGTGAGACG ATTGATTGGC
4861 ACCATGCGGT GGGTTTCAAT ATTGGCTTCA TOCACCACAT ACAGGCGGTA GCGGTGCGAC
4921 AGCGTGTACC ACAGCGGATG GTTCGGATAA TGCGACAGC GCACGGCGTT AAAGTTGTTT
4981 TGCTTCATCA GCAGGATATC CTGCACCATC GTCTGCTCAT CCATGACCTG ACCATGCAGA
5041 GATGATGCT CGTGAAGGTT AACGCTCGA ATCAGCAAAG GCTTGCCGTT CAGCAGCAGC
5101 AGACCATTTT CAATCCGCAC CTCGCGGAAA CCGACATGCG AGGCTTCTGC TTCAATCAGC
5161 GTGCCGTGG CGGTGTGCAG TTCAACCACC GCACGATAGA GATTGCGGAT TTCGGGCTC
5221 CACAGTTTCG GGTTTTCGAC CTTGAGACGT AGTGTGACGC GATCGGCATA ACCAACAAGC
5281 TCATCGATAA TTTACCCGCC GAAAGCGCGG GTGCCGCTGG CGACCTGCGT TTCACCTGCG
5341 CATAAAGAAA CTGTTACCGG TAGGTAGTCA CGCAACTGCG CGCACATCTG AACTTTCAGC
5401 TCCAGTACAG CGCGGCTGAA ATCATCATTA AAGCGAGTGG CAACATGGAA ATGCTTGATT
5461 TGTGTAGTCG GTTTATGCAG CAACGACAGC TCACGGAATA TGCCGCTCAT CCGCCACATA
5521 TCCTGATCTT CCAGATAACT GCGGTCACTC CAACGCAGCA CCATCACCGC GAGGCGGTTT
5581 TCTCCGGCGC GTAAAAATGC GCTCAGGTCA AATTGAGACG GCAAACGACT GTCTGGCCG
5641 TAACCGACCC AGCGCCCGTT GCACCAACAG TGAACGCGCG AGTTAACGCC ATCAAAAATA
5701 ATTCGCGTCT GGCCTTCTG TAGCCAGCTT TCATCAACAT TAAATGTGAG CGAGTAACAA
5761 CCGTCCGAT TCTCCGTGGG AACAAACGCG GGATTGACCG TAATGGGATA GGTACGTTG
5821 GTGTAGTGG GCGCATCGTA ACCGTGATC TGCCAGTTTG AGGGGACGAC GACGATATCG
5881 GCTCAGGAA GATCGCACTC CAGCCAGCTT TCCGGCACC CGTCTGGTGC CGGAAACCAG
5941 GCAAAGCGCC ATTGCGCATT CAGGCTGCGC AACTGTTGGG AAGGGGATC GGTGCGGGCC
6001 TCTTCGCTAT TACGCCAGCT GGCAGAAAGG GGATGTGCTG CAAGGCGATT AAGTTGGGTA
6061 ACGCCAGGGT TTTCCAGTC ACGACGTTGT AAAACGACGG GATCCCTCGA GGAATTCATT
6121 TATAGCATAG AAAAAACAA AATGAAATC TACTATATT TTACATACAT ATATTCTAAA
6181 TATGAAAGTG GTGATTGTGA CTAGCGTAGC ATCGCTTCTA GACATATACT ATATAGTAAT
6241 ACCAATACTC AAGACTACGA AACTGATACA ATCTCTTATC ATGTGGGTAA TGTCTCGAT
6301 GTCGAATAGC CATATGCCGG TAGTTGCGAT ATACATAAAC TGATCACTAA TTCCAAACCC
6361 ACCCGCTTTT TATAGTAAGT TTTTCACCCA TAAATAATA ATACAATAAT TAATTCTCG
6421 TAAAGTAGA AAATATATTC TAATTTATTG CACGGTAAGG AAGTAGAATC ATAAAGAACA
6481 GTGACGGATC CCAATTCGGG CATTTTGGT TTGAACATAA CAAAATGAAG TACATTTTGC
6541 TAATACTGCG GTGCATAATT GCATGCGTTT ATGGTGAACG CTACTGTGCC ATGCAAGACA
6601 GTGGCTTGCA GTGTATTAAT GGCACAAATT CAAGATGTCA AACCTGCTTT GAACGTGGTG
6661 ATCTTATTTG GCATCTTGCT AACTGGAAC TCAGCTGGTC TGTAATATTG ATTGTTTITA
6721 TAACAGTGTT ACAATATGGC AGACCACAA TTAGCTGGCT CGTTTATGGC ATTAAATGC
6781 TGATCATGTG GCTATTATGG CCTATTGTT TAGCGCTTAC GATTTTTAAT GCATACTCTG
6841 AGTACCAAGT TTCCAGATAT GTAATGTTG GCTTTAGTGT TGCAGGTGCA GTTGTAAAGT
6901 TTGCACTTTG GATGATGTAT TTTGTGAGAT CTGTTACGCT ATATAGAAGA ACCAAATCAT

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FIG. 4A-2

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6961 GGTGGTCTTT TAATCCTGAG ACTAATGCAA TTCCTTGTGT TAATGCATTG GGTAGAAGTT
7021 ATGTGCTTCC CTTAGATGGT ACTCCTACAG GTGTTACCCT TACTCTACTT TCAGGAAATC
7081 TATATGCTGA AGGTTTCAAA ATGGCTGGTG GTTTAACCAT CGAGCATTG CCTAAATACG
7141 TCATGATTGC TACACCTAGT AGAACCATCG TTTATACATT AGTTGGAAAA CAATTAAAAG
7201 CAACTACTGC CACAGGATGG GCTTACTACG TAAAATCTAA AGCTGGTGAT TACTCAACAG
7261 AAGCACGTAC TGACAATTG AGTGAACATG AAAAAATTATT ACATATGGTG TAACTAAACT
7321 TTCAAATGGG GGAATTCTGT GAGCGTATGG CAAACGAAGG AAAAAATTAGT TATAGTAGCC
7381 GCACTCGATG GGACATTTCA ACGTAAACCG TTTAATAATA TTTTGAATCT TATTCCATTA
7441 TCTGAAATGG TGGTAAACT AACTGCTGTG TGTATGAAAT GCTTTAAGGA GGCTTCCTTT
7501 TCTAAACGAT TGGGTGAGGA AACCAGAGATA GAAATAATAG GAGGTAATGA TATGTATCAA
7561 TCGGTGTGTA GAAAGTGTTA CATCGACTCA TAATATTATA TTTTTTATCT AAAAAACTAA
7621 AAATAAACAT TGATTAAATT TTAATAAAT ACTTAAAAAT GGATGTTGTG TCGTTAGATA
7681 AACCGTTTAT GTATTTTGAG GAAATTGATA ATGAGTTAGA TTACGAACCA GAAAGTGCAA
7741 ATGAGGTCGC AAAAAAATG CCGTATCAAG GACAGTTAAA ACTATTACTA GGAGAATTAT
7801 TTTTCTTAG TAAGTTACAG CGACACGGTA TATTAGATGG TGCCACCGTA GTGTATATAG
7861 GATCTGCTCC CGGTACACAT ATACGTTATT TGAGAGATCA TTTCTATAAT TTAGGAGTGA
7921 TCATCAAATG GATGCTAATT GACGGCCGOC ATCATGATCC TATTTTAAAT GGATTGCGTG
7981 ATGTGACTCT AGTGACTCGG TCGTTGATG AGGAATATCT ACGATCCATC AAAAAACAAC
8041 TGCATCCTTC TAAGATTATT TTAATTTCTG ATGTGAGATC CAAACGAGGA GGAAATGAAC
8101 CTAGTACGGC GGATTTACTA AGTAATTAGC CTCACAAAAA TGTCATGATT AGTATTTTAA
8161 ACCCGTGCGC GTCTAGTCTT AAATGGAGAT GCGCGTTTCC AGATCAATGG ATCAAGGACT
8221 TTTATATCCC ACACGGTAAT AAAATGTTAC AACCTTTTGC TCCTTCATAT TCAGGGCCGT
8281 CGTTTACAA CGTCGTGACT GGGAAAACCC TGGCGTTACC CAACTTAATC GCCTTGCAGC
8341 ACATCCCCCT TTCGOCAGCT GCGGTAATAG CGAAGAGGCC CGCACCGATC GCGCTTCCCA
8401 ACAGTTGCGC AGCCTGAATG GCGAATGGCG CCTGATGCGG TATTTTCTCT TTACGCTCT
8461 GTGCGGTATT TCACACCGCA TATGGTGAC TCTCAGTACC ATCTGCTCTG ATGCCGATA
8521 GTTAAGCCAG TACACTCCGC TATCTCTAAG TGACTGGGTC ATGGCTGCGC CCGACACCC
8581 GCCAACACCC GCTGACGGCG OCTGACGGGC TTGTCTGCTC CCGGCATCCG CTTACAGACA
8641 AGCTGTGACC GTCTCCGGGA GCTGCATGTG TCAGAGGTTT TCACCGTCAT CACCGAAACG
8701 CGCGAGGCAG

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FIG. 4A-3

FEATURES	From	To/Span	Description			
DNA	1	2233	pUC18 ori/amp resistance			
DNA	7687	8947	Thymidine Kinase R			
DNA	6080	3030 (C)	lac Z gene			
DNA	2240	3000	Thymidine Kinase L			
signal	6250	6130 (C)	Promoter P11			
signal	6300	6480	Promoter P7.5			
DNA	6496	7636	FIPV N cDNA			
ORF	6496	7629	1 N ORF			
1	CGAAAGGGCC	TCGTGATACG	CCTATTTTTTA	TAGGTTAATG	TCATGATAAT	AATGGTTTCT
61	TAGACGTCAG	GTGGCACTTT	TCGGGGAAAT	GTGCGCGGAA	CCCCTATTTG	TTTATTTTTT
121	TAAATACATT	CAAATATGTA	TCCGCTCATG	AGACAATAAC	CCTGATAAAT	GCTTCAATAA
181	TATTGAAAAA	GGAAGAGTAT	GAGTAITCAA	CATTTCGGTG	TGCCCTTAT	TCCCTTTTTT
241	GCGGCATTTT	GCCTTCCTGT	TTTTGTCTAC	CCAGAAACGC	TGGTGAAAGT	AAAAGATGCT
301	GAAGATCAGT	TGGGTGCACG	AGTGGGTAC	ATCGAACTGG	ATCTCAACAG	CGGTAAGATC
361	CTTGAGAGTT	TTCGCCCCGA	AGAACGTTTT	CCAATGATGA	GCACTTTTAA	AGTTCTGCTA
421	TGTGGCGCGG	TATTATCCCG	TATTGACGCC	GGGCAAGAGC	AACTCGGTG	CCGCATACAC
481	TATCTCAGA	ATGACTTGGT	TGAGTACTCA	CCAGTCACAG	AAAAGCATCT	TACGGATGGC
541	ATGACAGTAA	GAGAATTATG	CAGTGTGCC	ATAACCATGA	GTGATAACAC	TGCCGGCCAA
601	TTACTTCTGA	CAACGATCCG	AGGACCGAAG	GAGCTAACCG	CTTTTTTGCA	CAACATGGGG
661	GATCATGTAA	CTCGCCTTGA	TCGTTGGGAA	CCGGAGCTGA	ATGAAGCCAT	ACCAAACGAC
721	GAGCGTGACA	CCACGATGCC	TGTAGCAATG	GCAACAACGT	TGCGCAAAC	ATTAAGTGGC
781	GAACACTTA	CTCTAGCTTC	CCGGCAACAA	TTAATAGACT	GGATGGAGGC	GGATAAAGTT
841	GCCGAGCCAC	TTCTGCGCTC	GGCCCTTCGG	GCTGGCTGGT	TTATTGCTGA	TAAATCTGGA
901	GCGGTGAGC	GTGGGTCTCG	CGGTATCATT	GCAGCACTGG	GGCCAGATGG	TAGCCCTCC
961	CGTATCGTAG	TTATCTACAC	GACGGGGAGT	CAGGCAACTA	TGGATGAACG	AAATAGACAG
1021	ATCGCTGAGA	TAGGTGCCTC	ACTGATTAA	CATTGGTTAA	TGTCAGACCA	AGTTTACTCA
1081	TATATACCTT	AGATTGATT	AAAACCTCAT	TTTTAATTTA	AAAGGATCTA	GGTGAAGATC
1141	CTTTTTGATA	ATCTCATGAC	CAAAATCCCT	TAAAGTGAAT	TTTCGTTCCA	CTGAGCGTCA
1201	GACCCCGTAG	AAAAGATCAA	AGGATCTTCT	TGAGATCCTT	TTTTTCTGCG	CGTAATCTGC
1261	TGCTTGCAAA	CAAAAAAACC	ACCGCTACCA	GCGGTGGTTT	GTTTGCCGGA	TCAAGAGCTA
1321	CCAACTCTTT	TTCGGAAGGT	AACTGGCTTC	AGCAGAGCGC	AGATAACAAA	TACTGTCTTT
1381	CTAGTGTAGC	CGTAGTTAGG	CCAACACTTC	AAGAACTCTG	TAGCAACGCC	TACATACTTC
1441	GCTCTGCTAA	TCCTGTATAC	AGTGGCTGCT	GCCAGTGGCG	ATAAGTCGTG	TCTTACCGGG
1501	TTGGACTCAA	GACGATAGTT	ACCGGATAAG	GCGCAGCGGT	CGGGCTGAAC	GGGGGGTTGG
1561	TGCACACAGC	CCAGCTTGGG	GCGAACGACC	TACACCGAAC	TGAGATACTT	ACAGCGTGAG
1621	CATTGAGAAA	GCGCCACGCT	TCCCGAAGGG	AGAAAGGCGG	ACAGGTATCC	GGTAAAGCGC
1681	AGGGTCGGAA	CAGGAGAGCG	CACGAGGGAG	CTTCCAGGGG	GAAACGCGCT	GSTATCTTTAT
1741	AGTCTGTGCG	GGTTTGGCCA	CCTCTGACTT	GAGCGTGGAT	TTTTGTGATG	CTCGTCAGGG
1801	GGGCGGAGCC	TATGGAAAAA	CGCCAGCAAC	GCGGCTTTT	TACGGTTCC	GGCCTTTTGC
1861	TGGCCTTTTG	CTCACATGTT	CTTCTCTCGG	TTATCCCTG	ATTCTGTGGA	TAACCGTATT
1921	ACCGCCTTTG	AGTGAGCTGA	TACCGCTCGC	CGCAGCCGAA	CGAACGAGCG	CAGCGAGTCA
1981	GTCGCGAGG	AAGCGGAAGA	GCGCCCAATA	CGCAACCGC	CTCTCCCGCG	GCGTTGGCGG
2041	ATTCAATTAAT	GCAGCTGGCA	CGACAGGTTT	CCCGACTGGA	AAGCGGGCAG	TGAGCGCAAC
2101	GCAATTAATG	TGAGTTAGCT	CACTCATTAG	GCACCCAGG	CTTTACACTT	TATGCTTCCG
2161	GCTCGTATGT	TGTGTGGAAT	TGTGAGCGGA	TAACAATTTT	ACACAGGAAA	CAGCTATGAC
2221	CATGATTACG	CCAAGCTTTT	GCGATCAATA	AATGGATCAC	AACCAATATC	TCTTAACGAT
2281	GTTCTTCGCA	GATGATGATT	CATTTTTTAA	GTATTTGGCT	AGTCAAGATG	ATGAAATCTT
2341	CATTATCTGA	TATATTGCAA	ATCACTCAAT	ATCTAGACTT	TCTGTTATTA	TTATTGATCC
2401	AATCAAAAAA	TAAATTAGAA	GCGGTGGGTC	ATTGTTATGA	ATCTCTTTCA	GAGGAATACA
2461	GACAATTGAC	AAAATTCA	GACTTTCAAG	ATTTTAAAAA	ACTGTTTAAC	AAGGTCCCTA
2521	TTGTTACAGA	TGGAAGGGTC	AAACTTAATA	AAGGATATTT	GTTGACTTTT	GTGATTAGTT
2581	TGATGCGATT	CAAAAAAGAA	TCCTCTCTAG	CTACCACCGC	AATAGATCCT	GTTAGATACA
2641	TAGATCCTCG	TCGCAATATC	GCATTTTCTA	ACGTGATGGA	TATATTAAAG	TCGAATAAAG
2701	TGAACAATAA	TTAATTCTTT	ATTGTCATCA	TGAACGGCGG	ACATATTTCAG	TTGATAATCG
2761	GCCCCATGTT	TTCAGGTAAA	AGTACAGAA	TAATTAGACG	AGTTAGACGT	TATCAAATAG
2821	CTCAATATAA	ATGCGTGACT	ATAAAATATT	CTAACGATAA	TAGATACGGA	ACGGGACTAT
2881	GGACGCATGA	TAAGAATAAT	TTTGAAGCAT	TGGAAGCAAC	TAAACTATGT	GATCTCTTGG
2941	AATCAATTAC	AGATTTCTCC	GTGATAGGTA	TCGATGAAGG	ACAGTTCTTT	CCAGACATTG
3001	TTGAATCCG	AGCTTGGCTG	CAGGTGCGGG	ATCCCCCTG	CCCGGTTATT	ATTATTTTTG
3061	ACACCAGACC	AACTGGTAAT	GGTAGCGAAC	GGGCTCAGC	TGATTTCCGC	CGATACTGAC
3121	GGGCTCCAGG	AGTCGTGCCC	ACCAATCCCC	ATATGGAAC	CGTCGATATT	CAGCCATGTG

FIG. 4B-1

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3181 CCTTCTTCCG CGTGCAGCAG ATGGCGATGG CTGGTTTCCA TCAGTTGCTG TTGACTGTAG
3241 CGGCTGATGT TGAAC TGGAA GTCGCGCGGC CACTGGTGTG GGCCATAATT CAATTGCGGC
3301 GTCCCGCAGC GCAGACCGTT TTCGCTCGGG AAGACGTACG GGGTATACAT GTCTGACAAT
3361 GGCAGATCCC AGCGGTCAA ACAGGCGGCA GTAAGGCGGT CGGGATAGTT TTCTTGCGGC
3421 CCTAATCCGA GCCAGTTTAC CCGCTCTGCT ACCTGCGCCA GCTGGCAGTT CAGGCCAATC
3481 CGCGCCGGAT GCGGTGTATC GCTCGCCACT TCAACATCAA CGGTAATCGC CATTTGACCA
3541 CTACCATCAA TCCGGTAGGT TTTCCGGCTG ATAAATAAGG TTTTCCCTG ATGCTGCCAC
3601 GCGTGACCGG TCGTAATCAG CACCGCATCA GCAAGTGTAT CTGCCGTGCA CTGCAACAAC
3661 GCTGCTTCGG CCTGGTAATG GCCCGCCGCC TTCCAGCGTT CGACCCAGGC GTTAGGGTCA
3721 ATGCGGGTCG CTTCACTTAC GCCAATGTGCT TTATCCAGCG GTGCACGGGT GAACTGATCG
3781 CGCAGCGGCG TCAGCAGTTG TTTTATTCG CCAATCCACA TCTGTGAAAG AAAGCCTGAC
3841 TGGCGTTAA ATTGCCAACG CTTATTACCC AGCTCGATGC AAAAAATCCAT TTCGCTGGTG
3901 GTCAGATGCG GGATGGCGTG GGACGCGGCG GGGAGCGTCA CACTGAGGTT TTCGCCAGA
3961 CGCCACTGCT GCCAGGCGCT GATGTGCCCG GCTTCGACC ATGCGGTGCG GTTCGGTTGC
4021 ACTACGCGTA CTGTGAGCCA GAGTTGCCCG GCGCTCTCCG GCTGCGGTAG TTCAGGCAGT
4081 TCAATCAACT GTTACCTTG TGGAGCGACA TCCAGAGGCA CTTACCCGCT TGCCAGCGGC
4141 TTACCATCCA GCGCCACCAT CCAGTGCAGG AGCTOGTTAT CGCTATGACG GAACAGGTAT
4201 TCGCTGGTCA CTTGATGGT TTGCCCGGAT AAACCGAACT CTGCTGGTGT
4261 TTTGCTTCGG TCAGCGCTGG ATGCGGCGTG CGGTGCGCAA AGACCAGACC GTTCATACAG
4321 AACTGGCGAT CGTTCGGCGT ATCGCAAAA TCACGCGCGT AAGCCGACCA CGGGTTGCGC
4381 TTTTCATCAT ATTTAATCAG CGACTGATCC ACCCAGTCCC AGACGAAGCC GCCCTGTAAA
4441 CGGGGAACT GACGAAACGC CTGCCAGTAT TTAGCGAAAC CGCCAAGACT GTTACCCATC
4501 GGTGGGCGT ATTGCAAAG GATCAGCGGG CGGCTCTCTC CAGGTAGCGA AAGCCATTTT
4561 TTGATGGACC ATTTCGGCAC AGCCGGAAG GGCTGGTCTT CATCCACGCG CTGCTGGTATC
4621 GGGCAAATAA TATCGGTGGC CGTGGTGTGCT GCTCCGCGCG CTTCACTACTG CACCGGGCGG
4681 GAAGGATCGA CAGATTTGAT CCAGOGATAC AGCGGTCGT GATTAGCGCC GTGGCTGAT
4741 TCATTCOCCA GCGACCGAT GATCACTC GGGTGATAC GATCGCGCTG CACCATTGCG
4801 GTTACGCGTT CGCTCATGCG CGGTAGCCAG CGCGGATCAT CGGTGAGCG ATTGATTGGC
4861 ACCATGCGGT GGGTTTCAAT ATTGGCTTCA TCCACCACAT ACAGGCGGTA GCGGTGCGAC
4921 AGCGTGTACC ACAGCGGATG GTTCGGATAA TGCGAACAGC GCACGGCGTT AAGTGTGTTT
4981 TGCTTCATCA GCAGGATATC CTGCAACATC GTCTGCTCAT CCATGACCTG ACCATGCAGA
5041 GGATGATGCT CGTGAAGGTT AACGCTCGA ATCAGCAACG GCTTGCGGTT CAGCAGCAGC
5101 AGACCATTTT CAATCCGCAC CTCGCGGAAA CCGACATCGC AGGCTTCTGC TTCAATCAGC
5161 GTGCGGTGG CGGTGTGCG TTTCAACACG GCACGATAGA GATTGCGGAT TTCGGCGCTC
5221 CACAGTTTGG GGTTTTGGAC CTTGGAAGT AGTGTGACGC GATCGGCATA ACCAACAACG
5281 TCATCGATAA TTTCAACGCG GAAAGCGCG GTGCGCGCTGG CGAOCCTGCG TTCAOCCTGC
5341 CATAAAGAAA CTGTTACCGG TAGGTAGTCA CGCAACTCGC CGCACATCTG AACTTCAGCC
5401 TCCAGTACAG CGCGGCTGAA ATCATCATTA AAGCGAGTGG CAACATGGAA ATCGCTGATT
5461 TGTGTAGTCG GTTTATGCAG CAACGAGACG TCACGGAAAA TGCCGCTCAT CCGCCACATA
5521 TCTGTATCTT CCAGATAACT GCGGTCACTC CAACGACGCA CCATCACCGC GAGGCGGTTT
5581 TCTCCGGCGC GTAAAAATGC GCTCAGGTCA AATTGAGACG GCAAAACGACT TTCCTGGCCG
5641 TAACCGACCC AGCGCCCGTT GCACCACAGA TGAACGCGCG AGTTAACGCC ATCAACAAATA
5701 ATTGCGGTCT GGCTTCTCTG TAGCCAGCTT TCATCAACAT TAAATGTGAG CGAGTAACAA
5761 CCGTCCGGAT TCTCCGTGGG AACAAACGGC GGATTGACCG TAATGGGATA GGTACGTTG
5821 GTGTAGATGG GCGCATCGTA ACCGTGCATC TGCCAGTTTG AGGGGACGAC GACAGTATCG
5881 GCCTCAGGAA GATCGCACTC CAGCCAGCTT TCCGGCACCG CTTCTGGTGC CGGAAACCAG
5941 GCAAAGCGCC ATTCGCCATT CAGGCTGCGC AACTGTTGGG AAGGGCGATC GGTGCGGGCC
6001 TCTTCGCTAT TACGCCAGCT GCGGAAAGGG GGATGTGCTG CAAGGCGATT AAGTTGGGTA
6061 ACGCCAGGGT TTTCCAGTC ACGACGTGT AAAACGACGG GATCCCTCGA GGAATTCATT
6121 TATAGCATAG AAAAAACAA AATGAAATTC TACTATATTT TTACATACAT ATATTCTAAA
6181 TATGAAAGTG GTGATGTGA CTAGCGTAGC ATCGCTTCTA GACATATACT ATATAGTAAT
6241 ACCAATACTC AAGACTACGA AACTGATACA ATCTCTTATC ATGTGGGTAA TGTCTCGAT
6301 GTCGAATAGC CATATGCCGG TAGTTGCGAT ATACATAAAC TGATCACTAA TTCCAAAACC
6361 ACCCGCTTTT TATAGTAAGT TTTTCAACCA TAAATAATAA ATACAATAAT TAATTTCTCG
6421 TAAAACTAGA AAATATATTC TAATTTATTG CACGGTAAGG AAGTAGAATC ATAAAGAACA
6481 GTGACGGATC CCGGATGGC CACACAGGGA CAACGCGTCA ACTGGGGAGA TGAACCTTCC
6541 AAAAGACGTG GTCGTTCTAA CTCTCGTGGT CGGAAGAATA ATGATATACC TTGTGATTC
6601 TACAACCCCA TTACCCTCGA ACAAGGATCT AAATTTTGGA ATTTATGTCC GAGAGACCTT
6661 GTTCCCAAAG GAATAGGTAA TAAGGATCAA CAAATTGGTT ATTGGAATAC ACAGATTCTG
6721 TATCGTATTG TAAAAGGCCA CGGTAAGGAA CTCGCTGAGA GGTGTTCTTT TACTTCTTA
6781 GGTACAGGAC CTCATGCTGA TGCTAAATTC AAAGACAGAA TTGATGGAGT CTTCTGGGTT
6841 GCAAGGGATG GTGCCATGAA CAAGCCACA ACGCTTGGCA CTCGTGGAAC CAATAACGAA
6901 TCCAAACCAC TGAGATTGA TGGAAGATA CCGCCACAGT TTCAGCTTGA AGTGAACGCT

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FIG. 4B-2

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6961 TCTAGGAACA ATTCAAGGTC TGGTCTCAG TCTAGATCTG TTTCAAGAAA CAGATCTCAA
7021 TCTAGAGGAA GACACCATTG CAATAACCAG AATAATAATG TTGAGGATAC AATTGTAGCC
7081 GTGCTTGAAA AATTAGGTGT TACTGACAAA CAAAGGTCAC GTTCTAAACC TAGAGAACGT
7141 AGTGATTCCA AACCTAGGGA CACAACACCT AAGAATGCCA ACAAACACAC CTGGAAGAAA
7201 ACTGCAGGCA AGGGAGATGT GACAACCTTC TATGGTGCTA GAAGTAGTTC AGCTAACTTT
7261 GGTGATAGTG ATCTCGTTGC CAATGGTAAC GCTGCCAAT GCTACCCTCA GATAGCTGAA
7321 TGTGTTCCAT CAGTGTCTAG CATAATCTTT GGCAGTCAAT GGTCTGCTGA AGAAGCTGGT
7381 GATCAAGTGA AAGTCACGCT CACTCACACC TACTACCTGC CAAAGGATGA TGCCAAACT
7441 AGTCAATTCC TAGAACAGAT TGACCGTTAC AAGCGACCTT CTGAAGTGGC TAAGGATCAG
7501 AGGCAAGAA GATCCCGTTC TAAGTCTGCT GATAAGAAGC CTGAGGAGTT GTCTGTAAC
7561 CTTGTGGAGG CATAACAGA TGTGTTTGAT GACACACAGG TTGAGATGAT TGATGAGGTT
7621 ACGAAGTAAA CGCATGCCCG GGAATTCTGT GAGCGTATGG CAAACGAAGG AAAAATTAGT
7681 TATAGTAGCC GCACTCGATG GGACATTTCA ACGTAAACCG TTTAATAATA TTTTGAATCT
7741 TATTCCATTA TCTGAAATGG TGGTAAACT AACTGCTGTG TGTATGAAAT GCTTTAAGGA
7801 GGCTTCCTTT TCTAAACGAT TGGGTGAGGA AACCAGATA GAAATAATAG GAGGTAATGA
7861 TATGTATCAA TCGGTGTGTA GAAAGTGTA CATCGACTCA TAATATTATA TTTTATCT
7921 AAAAACTAA AAATAACAT TGATTAAATT TTAATATAAT ACTTAAAAAT GGATGTTGTG
7981 TCGTTAGATA AACCGTTTAT GTATTTTGAG GAAATTGATA ATGAGTTAGA TTACGAACCA
8041 GAAAGTGCAA ATGAGGTGCG AAAAAACTG CCGTATCAAG GACAGTTAAA ACTATTACTA
8101 GGAGAATTAT TTTTCTTAG TAAGTTACAG CGACACGGTA TATTAGATGG TGCCACCGTA
8161 GTGTATATAG GATCTGCTCC CGGTACACAT ATACGTTATT TGAGAGATCA TTTCTATAAT
8221 TTAGGAGTGA TCATCAAATG GATGCTAATT GACGGCCGCC ATCATGATCC TATTTTAAAT
8281 GGATTGCGTG ATGTGACTCT AGTGACTCGG TTCGTTGATG AGGAATATCT ACGATCCATC
8341 AAAAAACAAC TGCATCCTTC TAAGATTATT TTAATTTCTG ATGTGAGATC CAAACGAGGA
8401 GGAAATGAAC CTAGTACGGC GGATTTACTA AGTAATTACG CTCTACAAA TGTCATGATT
8461 AGTATTTTAA ACCCGTGGC GTCTAGTCTT AAATGGAGAT GCGCGTTTCC AGATCAATGG
8521 ATCAAGGACT TTTATATCCC ACACGGTAAT AAAATGTTAC AACCTTTTGC TCCTTCATAT
8581 TCAGGGCCGT CGTTTTACAA CGTCGTGACT GGGAAAACCC TGGCGTTACC CAACTTAATC
8641 GCGTTGCAGC ACATCCCCCT TTCGCCAGCT GCGGTAATAG CGAAGAGGCC CGCACCGATC
8701 GCGCTTCCCA ACAGTTGCGC AGCCTGAATG GCGAATGGCG CCTGATGGG TATTTTCTCT
8761 TTACGCATCT GTGCGGTATT TCACACCGCA TATGGTGCAC TCTCAGTACC ATCTGCTCTG
8821 ATGCCGCATA GTTAAGCCAG TACACTCCGC TATCGCTACG TGACTGGGTC ATGGCTGCGC
8881 CCGACACCC GCCAACACCC GCTGACGCGC OCTGAOGGGC TTGTCTGCTC CCGGCATCCG
8941 CTTACAGACA AGCTGTGACC GTCTCCGGGA GCTGCATGTG TCAGAGGTTT TCACCGTCAT
9001 CACCGAAACG CCGGAGGCAG

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FIG. 4B-3

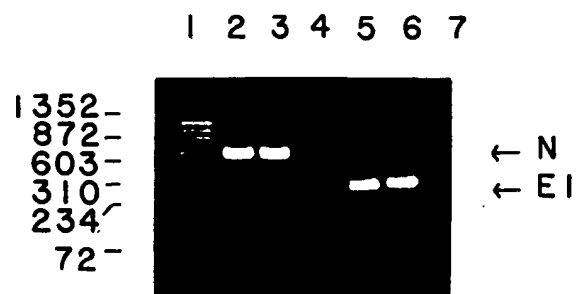


FIG. 5

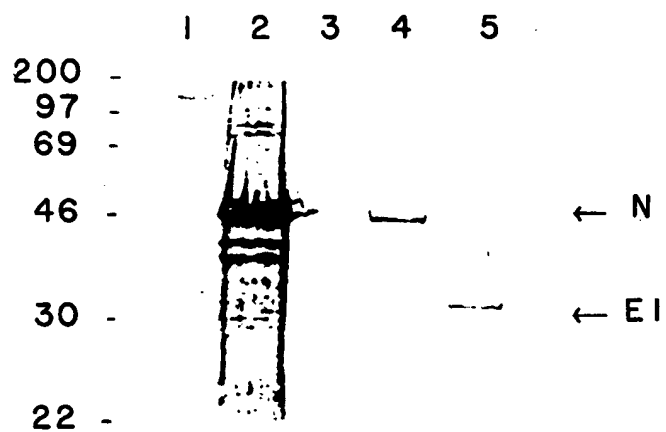


FIG. 6

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